



June 9, 1995

23088,1.16

Ms. Elizabeth A. Koesterer  
U.S. Environmental Protection Agency  
Region VII  
RCRA IOWA Section  
726 Minnesota Avenue  
Kansas City, Kansas 66101

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IOWA SECTION

**RCRA Facility Investigation Report  
Sauer-Sundstrand Plant  
Ames, Iowa  
RCRA Docket No. VII-91-H-0009**

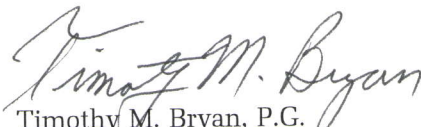
Dear Ms. Koesterer:

In compliance with the Administrative Order on Consent, Harding Lawson Associates is forwarding four copies of the RCRA Facility Investigation Report on behalf of our client, Sundstrand Corporation.

Please contact me at (708) 571-2162 or Mr. Bob Miller at (815) 226-2755 if you have any questions.

Yours very truly,

**HARDING LAWSON ASSOCIATES**

  
Timothy M. Bryan, P.G.  
Associate Hydrogeologist

TMB/jd  
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Enclosures

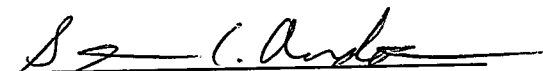
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                     William Coole - Sundstrand Corporation  
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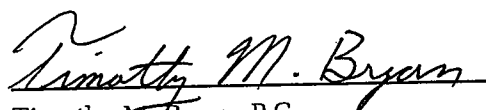
**RCRA Facility Investigation Report  
Sauer-Sundstrand Facility  
2800 East 13th Street, Ames, Iowa 50010  
USEPA Docket No. VII-91-H-0009**

**Volume I of III**

HLA Project No. 23088,1.16



Steven C. Anderson, CHMM  
Project Geologist



Timothy M. Bryan, P.G.  
Associate Hydrogeologist

June 9, 1995



**Harding Lawson Associates**  
Engineering and Environmental Services  
Oakbrook Terrace Tower, One Tower Lane, Suite 1300  
Oakbrook Terrace, IL 60181 — (708) 571-2162

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### **DISTRIBUTION**

## LIST OF ACRONYMS

bgs	below ground surface
C	Centigrade
CRP	Community Relations Plan
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DCQAP	Data Collection Quality Assurance Plan
DDSA	Designated Drum Storage Area
DMP	Data Management Plan
DOT	Department of Transportation
ESG	Environmental Service Group
F	Fahrenheit
g	gram
gpm	gallon(s) per minute
GPR	ground penetrating radar
HLA	Harding Lawson Associates
HSP	Health and Safety Plan
IDNR	Iowa Department of Natural Resources
L	liter
LCS	Laboratory Control Sample
MCL	maximum constituent level
MDL	method detection limit
MR	mud rotary
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
MW	monitoring well
NA	not analyzed, not available, or not applicable (specified where used)
ND	not detected or nondetect
PCE	perchloroethene or tetrachloroethene
PID	photoionization detector
POTW	publicly owned treatment works
ppm	part per million
PVC	polyvinyl chloride

## LIST OF ACRONYMS (Continued)

QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act of 1976
RFI	RCRA Facility Investigation
SMCL	secondary maximum constituent level
SWMU	Solid Waste Management Unit
1,1,1-TCA	1,1,1-trichloroethane
TCE	trichloroethene or trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
USDA	U.S. Department of Agriculture
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
µg	microgram(s)

## EXECUTIVE SUMMARY

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was performed at the Site located in Ames, Iowa. The purpose of the RFI was to assess impacts to soil and groundwater from the potential release of hazardous constituents from Solid Waste Management Units (SWMUs) at the Site. The RFI was conducted pursuant to the Administrative Order on Consent (VII-91-H-0009) issued on March 29, 1991 by USEPA to Sundstrand Corporation, Sauer-Sundstrand Company, and Susa Holding Inc.

The RFI was implemented in two phases. SWMUs with concrete containment structures were inspected for structural integrity in Phase I. SWMUs with potentially compromised containment structures, or SWMUs with no containment, were investigated with soil borings and analytical testing. Additionally, in Phase I, soil borings were drilled south and west of the facility to evaluate subsurface geologic conditions and potential groundwater migration pathways.

Phase II consisted of an extensive groundwater monitoring well abandonment/replacement program for existing wells which were suspected to be potential cross contamination pathways between shallow and intermediate water-bearing sands. Phase II also included groundwater sampling of new and existing wells, and sediment/surface water sampling. The results of the Phase I and Phase II investigations indicate that chemical impacts identified in the investigations are limited to organic constituents in groundwater in isolated and discontinuous sand lenses. The groundwater plume is primarily limited to the shallow sand lenses. Insignificant impacts observed in intermediate sands were the likely result of improper well construction from previous investigations, which were properly abandoned in this study. Based on dissolved metals groundwater data, metals are not an issue in groundwater at the Site.

Site geologic conditions consist of relatively impermeable, clayey glacial tills with horizontally and vertically discontinuous sand lenses. Data collected in this investigation indicate that shallow and previously described "intermediate" sandy aquifers are of limited areal extent and are not hydraulically connected. The geometry of the groundwater plume is very coincident with the orientation of shallow sand lenses; the plume does not occur in areas where sand layers in the till are missing or very thin.

An exposure assessment conducted for the Site evaluated potential exposure pathways from volatile organic compounds (VOCs) in groundwater. Four reasonable, potential pathways were evaluated for completeness: VOCs in groundwater to 1) surface water, 2) potable groundwater wells, 3) deeper aquifers, and 4) air. Onsite and offsite receptors in current and future land use scenarios were

considered. Only one exposure pathway, VOCs in groundwater to air, was considered likely to be complete. Health risks from this pathway would be negligible.

## 1.0 INTRODUCTION

This report was prepared by Harding Lawson Associates (HLA) to report the results and findings of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at the Site in Ames, Iowa. The Site is shown in Figures 1 and 2.

The RFI was conducted pursuant to the Administrative Order on Consent (Consent Order) Docket Number VII-91-H-0009, Section VI.B.6. The Consent Order was entered into on March 29, 1991 between the U.S. Environmental Protection Agency (USEPA), Sundstrand Corporation, Sauer-Sundstrand Company and Susa Holding Inc. (Respondents). The RFI was conducted in accordance with a set of project plans prepared by HLA including the Data Collection Quality Assurance Plan (DCQAP); as modified by the USEPA Notice of Approval with Modifications Letter dated August 3, 1993, the Health and Safety Plan (HSP), the Project Management Plan (PMP), the Data Management Plan (DMP), and the Community Relations Plan (CRP). These documents, including the USEPA modification letter, are referred to as the Project Plans. The purpose of this RFI was to assess impacts to soil and groundwater from the release or potential release of hazardous constituents from Solid Waste Management Units (SWMUs) at the Site.

This document was prepared for the sole use of the Respondents and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work.

## **2.0 BACKGROUND INFORMATION**

This section presents background information for the Site, including the Site setting (Section 2.1), Site history (Section 2.2), and list of SWMUs (Section 2.3). Included in this section is information gathered in previous studies. This information is clarified in later sections based on data gathered in this investigation to modify the conceptual hydrogeologic model presented in Section 5.0.

### **2.1 Site Setting**

#### **2.1.1 Site Location**

The Site is located at 2800 East 13th Street in Ames, Iowa (Figure 1). The Site is located in the Northeast  $\frac{1}{4}$  of the Northwest  $\frac{1}{4}$  of Section 6, Township 83 North, Range 23 West, Story County, Iowa. Hydrostatic transmission power systems are manufactured at this Site. These systems are used in several types of vehicles and equipment, primarily farm machinery and construction equipment. Figure 2 illustrates the geographic setting of the Site.

The Site is bounded on the north by 13th Street and on the east by Interstate 35. Doolittle Oil Company, Inc. owns a small portion of the property on the southern side of 13th Street. The Chicago and Northwestern (CNW) Railroad runs along the southern property line, and Story Construction Company owns the property south of the railroad. A 3M Corporation facility is located immediately west of the Site. The South Skunk River is located approximately one mile west of the Site and flows generally in a southerly direction.

Land use surrounding the Site is a mix of industrial, commercial, and agricultural uses. The land west and south of the Site is zoned for general industrial use. The land on the northern side of 13th Street is zoned for general commercial use, with the land further north being zoned for agricultural use. The majority of the land east of Interstate 35 is outside the corporate limits of the City of Ames and is used primarily for agricultural purposes. There is limited residential land use within one mile of the Site.

#### **2.1.2 Regional and Local Geology**

##### **Physiography**

The topography in central Iowa is characterized by rolling hills sloping toward the southwest with a surface gradient of approximately 0.008 ft/ft or 42 ft/mile. The topographic surface becomes steeper adjacent to the South Skunk River with a surface gradient of approximately 0.013 ft/ft or 700 ft/mile.

Changes in topography influence the direction of surface water drainage, but the general flow direction is toward the southwest (Figure 1).

The Site is located at an elevation ranging from 950 to 970 feet above mean sea level (msl). Figure 1 is a topographic map of the site property showing mean sea level elevations relative to the National Geodetic Vertical Datum. The topography of the site area is generally flat with gentle to moderately steep slopes. The lowest surface elevation in the proximity of the Site is 880 feet above mean sea level which occurs approximately one mile west of the Site along the south branch of the Skunk River. One-and-one-half miles north of the Site, ground surface elevations reach heights greater than 1020 feet above mean sea level.

### Soils

The native soils in the Site proximity belong to the Sparta-Dickinson-Farrar series which are "excessively drained to well drained, sandy and loamy soils formed in eolian, alluvial, and glacial till sediment; on upland or stream terraces" (USDA, 1984). The grain size distribution for these soils is generally as follows: 85-100% passing #4 sieve, 85-100% passing #10 sieve, 50-95% passing #40 sieve, and 25-75% passing #200 sieve.

### Glacial and Quaternary Geology

Unconsolidated Quaternary age sediments cover 97% of the land surface in Iowa. The glacial deposits consist of dominantly glacial till with some alluvial (stream) and eolian (wind) deposits present (Thompson, 1985). The glacial till in Story County is the result of three glacial periods, with the most recent ending 13,000 years ago.

The stratigraphy of the unconsolidated material at the Site has been described in previous reports (Section 2.2.1) based on the logs of approximately 90 soil borings and 34 groundwater monitoring wells on or near the Site. These studies indicate that there is a layer of brown fill material ranging from 0 to up to 6 feet thick underlying the topsoil. Within the zone of fill material there is a buried pre-existing soil horizon which grades downward into a tan, silty, sandy clay. At a depth of approximately 15 feet the tan clay grades into a hard gray, silty clay. Within these two silty, sandy clay units, there are numerous thin and discontinuous sand units.

### Bedrock Structure and Stratigraphy

The bedrock geology of central Iowa consists of Mississippian and Pennsylvanian age sedimentary rocks which are generally found between 0 and 200 feet below the surface. The depth to bedrock at



the Site is estimated to be 120 feet (Iowa Geological Bureau, 1995). The regional dip of the bedrock is approximately 15 feet per mile in a southwest direction. In the vicinity of Ames, Iowa the dip direction and angle may be locally affected by a northeast-southwest trending anticline (Iowa Geological Bureau, 1991).

### **2.1.3 Regional and Site Hydrogeology**

This section describes the general understanding of regional and site-specific hydrogeologic conditions prior to the implementation of the RFI. The data presented in this section is derived from previous site investigations (see Section 2.2.1). This information and the results of HLA's investigation presented in Sections 3 and 4 are incorporated into the Conceptual Hydrogeologic Model for the Site contained in Section 5.0. The conceptual hydrogeologic model indicates the site hydrogeology is generally consistent with prior studies but indicates that the sand lenses are more discontinuous than previously thought.

#### **Regional Hydrogeology**

In Story County, groundwater is obtained from two principal sources: shallow and intermediate sand zones within the Quaternary age unconsolidated sediments, and several deep bedrock aquifers of Cambrian and Ordovician age. The Quaternary age unconsolidated material consists mostly of glacial till, alluvium and eolian deposits. At the Site, only the glacial till and alluvial deposits are present. The sediments comprising these deposits consists mainly of clay, silt, sand, and gravel.

The City of Ames, Iowa obtains much of its water from wells drilled into a near surface, buried channel aquifer. This aquifer, known as the Ames Aquifer, was a pre-existing river channel that has since been covered by unconsolidated materials from the three glacial periods. The aquifer, consisting mainly of sand and gravel, is interconnected with recent alluvial deposits along the South Skunk River and Squaw Creek. The primary recharge area for this aquifer is northeast of Ames from the South Skunk River and to a lesser extent from Squaw Creek to the south and west. Based on pumping tests from wells in southeast Ames, the Ames Aquifer appears to be unconfined. However, directly under the city of Ames, the Ames Aquifer takes on the characteristics of being a confined aquifer (Austin et al., 1984).

#### **Site Hydrogeology**

Information on the Site hydrogeology was obtained from previous investigations that included the installation of 34 monitoring wells. Previous studies by HDR (1986 and 1989) indicated that in the proximity of the Site, two main water zones, shallow and intermediate, exist within the

unconsolidated sediments. The shallow water bearing zone extends from the top of the water table (four to six feet bgs) down to where the subsurface material changes to a hard, gray, silty clay (15 to 20 feet bgs). It is this gray clay unit that inhibits transmission of water from a sand lens to adjacent sand lenses or the intermediate sand zone. Within the gray, silty clay unit, lays the intermediate sand zone, where the primary sources of groundwater are the sand units. These sand units within the intermediate sand zone generally differ from the sand units within the shallow most aquifer by being thicker, as demonstrated by MW-30 where the sand reaches a thickness of approximately 40 feet.

Data collected by HDR (1989) at the Site indicates that the groundwater flow direction in the shallow sand zone is to the southwest, generally reflecting the surface topography. HDR/Terracon soil borings and monitoring well data show in most cases, that groundwater was first encountered at 4 to 6 feet below ground surface (bgs). Below the shallow sand zone, groundwater occurrences were limited to mainly sand units located within the tan and gray silty clay units. The groundwater flow direction within the intermediate sand zone is generally to the south.

#### **Areas of Recharge and Discharge**

The sources of recharge for the shallow sand zone at the Site are primarily from precipitation at the Site and adjacent areas. Surface runoff flows by means of a drainage ditch and into the flood control basin. Possible sources of recharge and discharge include the drainage ditch and the flood control basin (Figure 3).

The intermediate sand zone beneath the Site probably receives minimal recharge from the shallow sand zone because of the dense, gray silty clay above it. Previous investigations indicate that groundwater discharge to surface water does not occur at the Site or in the immediate vicinity.

#### **Horizontal and Vertical Hydraulic Conductivity**

In the 1986 Remedial Investigation Final Report, HDR reported the laboratory results on the vertical hydraulic conductivity of core sections taken from wells MW-15D and MW-17. The vertical hydraulic conductivity of various lithological units from these cores was evaluated in the laboratory by performing a constant head permeameter test. In general, their results indicated that the units with the highest vertical hydraulic conductivity were the sands and the brown clay unit immediately above the sands with a hydraulic conductivity of  $10^{-6}$  centimeters per second (cm/sec). The gray clay unit had the lowest vertical hydraulic conductivity with values ranging from  $10^{-8}$  cm/sec to  $10^{-9}$  cm/sec. HDR evaluated the horizontal in-situ hydraulic conductivity at the Site by conducting slug tests on

selected monitoring wells and using the Hvorslev method to evaluate the results. The horizontal hydraulic conductivity for the shallow sand zone ranges from  $10^{-2}$  to  $10^{-6}$  cm/sec.

### **Site Hydrology**

Hydrologic features at the Site include a drainage ditch and a flood control basin. The drainage ditch (Figure 3) originates to the east of the Site along Interstate 35, then extends southward and parallel to the highway for approximately 300 feet. The drainage ditch then cuts westward across the Site property for approximately 600 feet, then extends south for approximately 300 feet where it terminates in the flood control basin. The flood control basin in the southwestern corner of the Site covers approximately 20,000 square feet and is triangular in shape.

### **2.1.4 Climate**

#### **Temperature**

Average monthly temperatures range between 60-80°F in the summer and 15-30°F in winter (Iowa State University, 1991). The mean average temperature for 1989 was 47.6 degrees Fahrenheit and for 1990 the mean average was 50.5 degrees Fahrenheit. The temperature data collected by Iowa State University (1991) was from a temperature gaging station located between Ames and P

#### **Precipitation**

The mean annual precipitation for Story County is approximately 34 inches (USDA, 1989). Precipitation data for 1989 and 1990 for the city of Ames, Iowa indicated that July 1990 had the greatest amount of precipitation recording 9.06 inches with the lowest in November 1989 observing 0.12 inches (Ames Water Department, 1991).

### **2.2 Site History**

Sundstrand owned and operated the Site from its opening in 1972 until January 1, 1987, when Sundstrand entered into a joint venture with Sauer Getriebe AG (Sauer). The Site was then owned and operated by the joint venture of Sundstrand and Sauer as the Sundstrand-Sauer Company. Sundstrand sold its interest in the joint venture to Sauer on March 31, 1989. Ownership of the real estate was transferred to Sauer Holding of Story County at that time. Sundstrand-Sauer Company continued to operate the Site until December 31, 1989, at which time an independent entity, Sauer-Sundstrand Company was established. Sauer-Sundstrand has operated the Site since January 1, 1990.

### **2.2.1 Previous Investigations**

Several hydrogeologic studies have been conducted at the Site since 1984. The following section contains a listing of selected reports and a brief summary of major findings or conclusions for each document.

- 1) Terracon Consultants Inc. Groundwater Monitoring Program, Underground Storage Tank Systems, February, 1984. Terracon installed eight (8) monitoring wells labelled MW-1 through MW-6 with well nests at MW-2 and MW-6. Subsurface geology was evaluated, but groundwater samples were not collected.
- 2) HDR. Public Health Assessment of Releases From an Inactive Temporary Waste Storage Facility, October, 1986. HDR prepared a Public Health Assessment for the Designated Drum Storage Area (DDSA) that was submitted to EPA. The Public Health Exposure Analysis concluded that there was no risk to human health or the environment.
- 3) HDR Engineering Inc. (HDR). Remedial Investigation Study, December, 1986. Sundstrand retained HDR to perform a voluntary investigation at the Site. HDR prepared a "Remedial Investigation" report which was submitted to USEPA. The Remedial Investigation study was conducted in four phases:
  - Phase I - July 8 through July 19, 1985
  - Phase II - September 3 through September 19, 1985
  - Phase III - November 13 through November 14, 1985
  - Phase IV - March 24 through March 26, 1986

Eighty-four soil borings were drilled to define the stratigraphy beneath the Site, and to collect samples (56 in total) for laboratory analysis. Field procedures included the use of hollow stem augers and a continuous hollow stem sampling system to log the samples, and a photoionization detector (PID) for field screening. Based on these borings, the Site was found to be underlain by a layer of fill which was further underlain by buried top soil grading to brown clay. A hard gray clay was generally found at depth of 15 to 20 feet, which contained some sand seams at depth. Field screening results were used to select samples which were analyzed onsite using a field gas chromatogram. Results of these analyzes were also used to assess subsequent boring locations. Samples were analyzed for tetrachloroethylene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA) to determine the presence of these compounds in the unsaturated zone (vadose zone). Four soil samples were submitted to an independent laboratory for quality assurance checks.

Seventeen monitoring wells (MW10 through MW26) were installed, developed and sampled at selected boring locations. Groundwater samples were collected to assess the extent of volatile organic compounds (VOCs). The wells were constructed of 2-inch diameter stainless steel well screen and riser pipe. A 2.75 foot length of 0.01 inch slot size well screen was installed at the base of each well and a gravel pack was used in the borehole annulus to approximately two feet above the top of the well screen. The remaining annulus was backfilled with a bentonite seal and a bentonitic rich cement grout. Prior to sampling for VOCs, each well was developed by purging a minimum of three borehole volumes of waters.

The Remedial Investigation concluded that the shallow sand zone was impacted by specific VOCs, primarily 1,1,1-TCA and PCE. The leading edge of the groundwater constituent plume appeared to be north of the Site's southern property line. The presence of VOCs in the intermediate sand zone was considered to be nonexistent.

- 4) HDR. Monitoring Well Installation and Sampling, August, 1990. HDR prepared a summary report that detailed field activities that were undertaken between the completion of the Remedial Investigation in 1986 and May 1989. Field activities included the collection of water level measurements and groundwater sampling events in March and September, 1988 and May, 1989. Also during March, 1988, monitoring wells MW-27 through MW-30 were installed. The report concluded that VOCs were not detected in wells south of the Site in the shallow sand zone. The report also concluded that VOCs were not transported off site in surface water.
- 5) HDR. Soil Vapor Study, November, 1989. HDR conducted a soil vapor survey to delineate VOC migration in soil and locate additional monitoring wells. The soil vapor survey included the collection of 30 samples followed by analysis for 1,1,1-TCA and PCE using a field gas chromatograph with an electron capture detector. The soil vapor survey was qualitative in nature but was used to identify monitoring wells to be sampled and locate the installation of MW-31 and MW-32. The report also concluded that elevated levels of PCE and 1,1,1-TCA were found in the west-central portion of the Site.
- 6) HDR. Monitoring Well Installation and Sampling Summary Report, August, 1990. HDR submitted a final summary report to USEPA with additional analytical groundwater data. Twenty-five (25) monitoring wells were sampled, providing an evaluation of the extent of VOCs in the shallow and intermediate sand zones. HDR concluded that VOCs were not detected in wells south of the Site.

### **2.2.2 Waste Generating Operations**

Vapor degreasers utilizing organic solvents are used in various stages of the manufacturing process at the Site. The solvents are used to remove cutting oil and clean the individual metal parts before the transmission systems are assembled. Solvents previously used in the vapor degreasers included tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), and trichlorofluoromethane. These degreasers have been eliminated.

In addition to the vapor degreasers, other processes at the Site have generated waste materials. Sauer-Sundstrand staff have identified that methylene chloride was used as a paint stripper. This practice has been discontinued. Toluene and xylene were used in the past and still are used as paint solvents.

Hazardous wastes, including spent PCE, 1,1,1-TCA, methylene chloride, and trichlorofluoroethane have been shipped in the past from the Site for offsite disposal. According to Site personnel, all hazardous wastes are stored on-site for less than 90 days before being manifested and transported to a RCRA-permitted disposal facility in accordance with applicable regulations.

Sauer-Sundstrand uses solvent 140 to wash parts at the Site. Solvent 140 replaced Stoddard solvent and has a flash point greater than 140°F. Stoddard solvent has a flash point of 102°F. Solvent 140 replaced Stoddard Solvent in June 1990. Solvent 140 is removed from parts wash tanks using a mobile tank and taken to a recovery distillation process for reclamation. Waste generated by the solvent recovery process consists of oily water, which is discharged to the used oil storage tank (SWMU 13).

### **2.2.3 Release Information**

#### **Hydraulic Oil Releases**

On June 30, 1989, Sauer-Sundstrand discovered a release of hydraulic oil outside the western side of the building. Sauer-Sundstrand is remediating this release under Iowa Department of Natural Resources (IDNR) supervision. Oil had leaked through a faulty seal around a ground wire from the base of a transmission testing stand when the base became about two-thirds full. The oil followed the ground wire to the exterior of the building. Sauer-Sundstrand has taken two steps to ensure that additional releases are unlikely to occur. Sauer-Sundstrand implemented work procedures that avoid filling the base more than about one quarter full, and repaired the faulty seal. Additionally, Sauer-Sundstrand removed the soil impacted by this release and disposed of it offsite. Sauer-Sundstrand had also installed a monitoring and recovery well which was used monthly to remove accumulated hydraulic oil. The recovery process has recovered aged oil but no fresh oil. This release has been labelled SWMU 5 (see Section 2.3).

On November 30, 1990, during an equipment test being conducted to the south of the building, a hydraulic hose broke, releasing about fifteen gallons of hydraulic fluid. The spill occurred about 150 feet south of the building, near the propane storage area shown on Figure 4. Sauer-Sundstrand excavated and disposed of approximately twenty cubic yards of soil impacted by this release and disposed of it offsite. Subsequent testing indicated that no hydraulic fluid remained in the spill area.

#### **Solvent 140 Release**

During the manufacturing process some of the power system parts are washed with Solvent 140, a petroleum-based product. Solvent 140 is distributed to wash tanks throughout the plant from an onsite storage tank through a dedicated distribution system, all of which is aboveground. When the solvent is spent, that is when it contains enough hydraulic oil that an oily film remains on the part after washing, it is transported in portable steel tanks to the solvent recovery system where it is filtered and then distilled. Approximately 150 gallons of solvent are distilled on a batch basis once

every two to three days. The distilled solvent is returned to the solvent storage tank and the still bottoms, consisting primarily of hydraulic oil and small quantities of water and Solvent 140, are pumped to the above-ground used oil storage tank, SWMU 13 (see Section 2.3). The material from this aboveground tank is transferred offsite for refining or used as a raw material.

On July 8, 1992, the level sensor, which is part of the distillation column sump level control loop, failed causing the still bottoms to overflow the sump. The still bottoms flowed across the floor to a nearby doorway and spilled out the doorway onto the ground. The malfunction was discovered less than one hour later and the overflow was stopped. It was estimated by Sauer-Sundstrand personnel that less than 10 gallons of still bottoms overflowed the sump. This estimate was based on the duration of the leak and the known flow rate of the still bottoms.

After the overflow was stopped, workers began excavating by hand the gravel backfill into which the materials spilled. The excavated material was placed in four 55-gallon steel drums. A hydraulic excavator which was present in connection with a UST removal project at the Site was then used to continue the excavation of the gravel backfill along the building foundation to the west and outward from the building to the south around the underground pipes. A PID was used to screen soils during the excavation. According to visual observations and PID measurements, it appeared that most of the overflowed material flowed along the building foundation to the west following the grade in that area. Impacted gravel was removed from beneath the doorway area to the west along the foundation until the PID readings on all sides and bottom of the excavation indicated background (approximately 10 parts per million [ppm]). It was not possible to remove all of the impacted backfill at the western limit of the excavation without removing part of the asphalt driveway which would have rendered the shipping and receiving area inaccessible. PID readings were decreasing at the point where the excavation activities ceased (at the beginning of the asphalt driveway). Since mechanical excavating equipment was available, significant over excavation was undertaken including excavation along pipelines. The excavated area along the foundation was approximately 40 feet in length, 5 feet in width and ranged in depth from 2 to 8 feet.

Excavation and PID readings were conducted further to the south of the building foundation to determine if the overflowed material might have moved in that direction. No PID measurements above background were noted for this area. However, while excavating in this area, two utility lines, not shown on the underground piping drawings at the Site, were struck and broken. The two lines broken were a 4-inch non-contact stormwater line from several roof drains on the building and a 4-inch line which intermittently carries effluent from the wastewater treatment facility to the city

sanitary sewer. The stormwater line contained no water. However, water began flowing in the wastewater line emptying approximately 100 gallons into the excavation. The flow was stopped and the wastewater was pumped back to the wastewater treatment facility (SWMU 6).

After the water was removed from the excavation and the broken lines were repaired, the entire excavation was backfilled with clean fill material. Approximately 100 cubic yards of soil were removed during the excavation and stockpiled at the Site, and are undergoing remediation under IDNR guidance.

### Petroleum and Other USTs

Six USTs were located in a tank farm south of the Site loading dock. The tanks were designated 1 through 6. Tank 1 stored virgin automotive Type F oil, tank 2 stored virgin Hytran Oil, tank 3 stored diesel fuel, tank 4 has been used to store virgin Stoddard Solvent and subsequently virgin 10 W 30 oil, tank 5 stored virgin Hytran Oil, and Tank 6 stored waste oil (Groundwater Technology, Inc., 1988; Groundwater Service and Supply, Inc., 1992). Additionally, a seventh UST for paint storage secondary containment (SWMU 10) was located north of the tank farm. Tank 3 was a 10,000-gallon capacity tank that was excavated and removed in November 1987. At the time of the tank removal, a release was discovered. The suspected release was reported to IDNR on May 24, 1989. A soil boring drilled at the former Tank 3 location on July 25, 1989 found released materials of an unknown source. IDNR field office Number Five investigated the release on August 16, 1989 and concluded the released materials were hydraulic fluid with traces of Stoddard Solvent that had been spilled during transfer of solvent from tanker trucks to UST Number 4 (an 8,200-gallon capacity UST that had been storing Stoddard Solvent) during 1971 to 1987.

In November 1989 Groundwater Technology, Inc. advanced one soil boring in the vicinity of Tank 3, and encountered separate phase hydrocarbons on the top of the water table. Subsequently in June 1990 a recovery well was installed within the backfill of the former Tank 3 excavation. Following installation, the well was manually bailed once a week for the next six weeks. A total of 50 gallons of groundwater was recovered from the recovery well, and disposed at the on-site wastewater treatment facility. Free floating separate phase hydrocarbons were not encountered on the water table surface during the subsequent six weekly visits, though the groundwater was observed to exhibit a sheen on each visit (Groundwater Service and Supply, Inc., 1992).

The five remaining tanks were removed in July 1992. The impacted soil from UST excavation was placed in an area on the east side of the Site for planned bioremediation (Groundwater Service and



Supply, Inc., 1992). The Tank Closure Report, the Site Cleanup Report, the Potential 140 Solvent Release Investigation Report and IDNR correspondence, and Overexcavation of 140 Solvent Release Report and IDNR correspondence are included as Appendixes A, B, C and D, respectively.

Subsequent to the UST removals and at the request of IDNR, a Site Cleanup Report (SCR) was prepared by Groundwater Service and Supply, Inc. Per IDNR regulations, the SCR classified the site as "low risk," referring to a single hydrocarbon level above IDNR limits. Sauer-Sundstrand elected to remediate the impacted area south of the building rather than monitoring the location for 12 years as proposed by IDNR. Excavation of the location was conducted and PID measurements of the sidewalls and bottom collected. Laboratory samples were also collected, and the data was reported to IDNR. It was requested that the site be reclassified as "no risk" and that the UST project be considered closed. IDNR has granted both these requests.

Excavated soils were bioremediated on-site to achieve levels of hydrocarbons below IDNR limits. IDNR has accepted laboratory results and considers the soil clean, granting permission to use the soils as Sauer-Sundstrand sees fit (McConnell, 1995).

Two additional tanks, designated Tanks 8 and 9, were located on the east side of the facility. Tank 8 stored diesel and had a 10,000-gallon capacity. Tank 9 stored gasoline and had a 2,000-gallon capacity. The tanks were removed in November 1987 (Groundwater Technology, Inc., 1988).

SWMU 8 (Tank 10) was removed in July 1992. Prior to tank removal, soil borings in the area of the UST identified the presence of aromatic compounds. The depth of the tank necessitated sheet piling to allow removal and no post excavation sidewall or floor soil samples were collected.

#### **2.2.4 Closure Activities**

The Designated Drum Storage Area/Interim Status Container Storage Area (DDSA/ISCSA) areas were used to store drums of wastes from 1972 through 1982. A description of the DDSA/ISCSA closure is presented in Appendix E. In September 1982, use of the DDSA was discontinued when an engineered storage facility was constructed in another area of the Site. Wastes stored in this area included spent PCE and 1,1,1-TCA. In 1993, Sundstrand began closure of the DDSA/ISCSA.

The USEPA-approved closure plan for the DDSA/ISCSA established clean closure soil cleanup levels to be 0.2 parts per million (ppm) for PCE and 3.4 ppm for 1,1,1-TCA. Based on the results of previous investigations of the DDSA/ISCSA, two distinct areas of chemically impacted soil in the vicinity of the

DDSA/ISCSA area were identified where the total combined concentration of 1,1,1-TCA and PCE was greater than or equal to 2 ppm (HDR, 1986). The total surface area of the affected soil was estimated to be less than 27,000 square feet.

Based on the results of previous investigations, proposed closure of the DDSA/ISCSA consisted of in-place aeration and bioremediation of the affected soil. As approved by the USEPA, the soil was mechanically aerated (tilled) using a 16-row chisel-type plow pulled by a large farm tractor. Tilling facilitated volatilization of VOCs. This process was continued until the concentrations of VOCs in the soils were below the cleanup levels. The effectiveness of soil remediation was monitored by independent laboratory analysis of soil samples from all treatment zones.

Tilling was accomplished in 12-inch depth increments (lifts). Initially, the upper 12 inches of soil were remediated. Once VOC concentrations in the first 12-inch lift met cleanup levels, the upper 8 inches of the soil was excavated and temporarily staged. Removal of only the upper 8 inches of soil prevented inadvertent removal or disturbance of unremediated soil below the initial 12-inch treatment lift. The process was then repeated in 12-inch lifts until soil remediation was completed. The remediated soil in each lift was transported to the staging area located near the DDSA/ISCSA excavation.

Based upon the laboratory test data and published information, the base of the excavation (maximum extent of excavated soil), was within the zone that soil can be expected to be saturated by groundwater due to the effect of capillary rise.

USEPA acknowledged closure completion of the DDSA/ISCSA area in a letter to Sundstrand dated November 4, 1994.

### **2.3 Solid Waste Management Units (SWMUs)**

The DCQAP identified and presented detailed descriptions for 15 SWMUs at the Site. SWMU locations are illustrated on Figure 4. Of the 15 SWMUs, four (SWMUs 5, 7, 8 and 10) have been investigated and are being addressed under supervision by IDNR and, therefore, were not separately investigated under this RFI. SWMU 3 is also an IDNR-supervised project, but was included in the concrete floor inspection program reported in this RFI. SWMUs 1, 9, and 11 have undergone investigations and remediation regulated by USEPA, and that program is summarized in Section 2.2.4. The remaining SWMUs (2, 4, 6, 12, 13, 14 and 15) were included in the Phase I investigation conducted for this RFI and are described in Section 3.0.

Presented below is a list of the 15 SWMUs, the program under which it is being supervised, and references to sections of this RFI report where the program for each SWMU are described.

<u>SWMU Number</u>	<u>SWMU Description</u>	<u>Regulation Program</u>	<u>Text References</u>
1	Former Designated Drum Storage Area (DDSA)	RCRA closure	2.2.4
2	Current Hazardous Waste Storage Area	RFI (concrete floor inspection)	3.2
3	Solvent 140 Recovery Still	RFI (concrete floor inspection) and IDNR-supervised project	3.2, 2.2.3
4	Acid Neutralization Sump	RFI (soil borings)	3.4.2
5	Test Stand Hydraulic Oil Spill Area	IDNR-supervised project	2.2.3
6	Wastewater Treatment Facility	RFI (concrete floor inspection and soil borings)	3.2, 3.4.3
7	Spent Hydraulic Oil Storage Tank	IDNR-supervised project	2.3
8	Test Lab Used Oil Tank	IDNR-supervised project	2.3
9	Interim Status Container Storage Area (ISCSA)	RCRA closure	2.2.4
10	Paint Storage Secondary Containment Tank	IDNR-supervised project	2.3
11	Waste Paint Drum Storage Area	RFI (encompassed within USEPA RCRA closure)	
12	Sound Lab Used Soil Sump	RFI (concrete floor inspection)	3.2
13	Used Oil Storage Tank	RFI (concrete floor inspection and soil borings)	3.2, 3.4.3
14	Used Oil Filtration System	RFI (concrete floor inspection and soil borings)	3.2, 3.4.1
15	Oil Collection Pans and Catch Basins	RFI (concrete floor inspection and soil borings)	3.2, 3.4.4

Complete SWMU descriptions are included in Appendix E.

### **3.0 PHASE I INVESTIGATION**

#### **3.1 Phase I Investigation Approach**

Phase I Investigations were conducted at eight of the 15 SWMUs (SWMU Nos. 2, 3, 4a, 6, 12, 13, 14 and 15) included in this RFI. Phase I investigation activities included: 1) concrete floor inspections for SWMUs with containment, and 2) soil borings. The purpose of the soil borings/sampling at SWMUs was to evaluate potential releases associated with the SWMUs.

As described in the Project Plans, SWMUs with concrete containment structures would not require intrusive activities if visual inspection of the structures indicated the structures were intact. Therefore, the concrete inspection task was critical in screening whether SWMUs with containment warranted further investigations.

In addition to soil borings performed around selected SWMUs, soil borings were also performed along the southern and western boundary of the Site to characterize geologic conditions and evaluate potential groundwater migration pathways.

#### **3.2 Concrete Floor Inspection**

HLA conducted an inspection of secondary containment systems at SWMUs 2, 3, 6, 12, 13, 14 and 15 on August 17, 1993. Secondary containment systems include concrete slabs, curbing, metal pans and similar structures. The objective was to inspect the floor and building exteriors to evaluate whether a release had potentially occurred and if analytical sampling was necessary. Each SWMU was inspected to identify potential release pathways through the secondary containment of the SWMU. Once a release pathway was identified, HLA looked for evidence of a release. Visual staining was the primary means of identifying the evidence of a release. Where it was possible to look at the soils outside of a SWMU secondary containment system, these soils were inspected for visual staining and, if found, were analyzed using a photoionization detector. Photographs of each SWMU, especially the areas of potential migration, were taken and are included in the September 15, 1993 Summary Report. A copy of the letter report detailing the inspection results was previously presented to USEPA, and is included with this report (Appendix F).

For SWMUs that relied upon slabs of formed concrete for secondary containment, the concrete was inspected for containment-related conditions and any flaws or construction features that could reduce the containment capability. Cracks, perforations through the concrete, and expansion joints were of

primary concern followed by the surface condition of the concrete and any protective coating on the surface.

For SWMUs that had other types of secondary containment such as catch basins, sumps or catch pans, the condition of the structure was inspected to see if there were any leaks. The concrete surrounding or beneath these features was also examined for competency and evidence of leakage through the secondary containment that could cause subsequent leakage through the concrete.

Observations of each SWMU are summarized below following a brief description of each SWMU. The recommendation made concerning whether the containment appears adequate or whether the analytical sampling program was required is included.

#### **SWMU Number 2, Current Hazardous Waste Storage Unit**

The hazardous waste storage unit is a concrete, masonry enclosed room with metal-panel siding and locked door access. The concrete floor has recessed sections where hazardous waste containers are stored. The recessed areas provide the secondary containment capacity. The lower approximately two feet of the walls is concrete with masonry units above on the interior partition walls and metal panel siding on the exterior walls. The concrete forming the walls and the floor slab are free of joints that could be potential migration pathways. The floor slab is sound; free of cracks, spalling, scaling or other damage.

A portion of the wall of the hazardous waste storage area is constructed of concrete because it is located below grade. The exterior of the building was not inspected because if a leak occurred, no staining or other indications would be evident at the surface.

Based on the soundness of the floor, no additional borings were necessary in the vicinity of SWMU Number 2, the Current Hazardous Waste Storage Area.

#### **SWMU Number 3, Solvent 140 Recovery Still**

The Solvent 140 Still is electrically powered and used to distill spent Solvent 140 by reclaiming the solvent and separating used hydraulic oil. The still is elevated above the concrete floor on a frame which is bolted to the floor. The still is located near the exterior wall and near a joint between the floor slab and a column footing. This joint is filled with a preformed expansion joint filler.

The exterior wall is metal panel siding that extends to the floor. In the vicinity of the still, this floor-wall connection is protected by a section of angle-iron that is bolted to the floor to prevent potential spills from passing beneath the exterior wall. The angle iron has been caulked with a silicone caulk to prevent seepage beneath the angle-iron. The expansion joint at a column footing is located immediately adjacent to the still. The expansion joint is not covered with epoxy resin nor is it evident that a water-stop was included in the expansion joint.

The room in which the still is located is also used for the storage of hydraulic oil and is where SWMU Number 14, the used oil filtration system, is located. The floor has an epoxy coating. Evidence of hydraulic oil spills can be seen on the floor. It was not possible to determine whether these stains are due to the new hydraulic oil, used hydraulic oil, or from the Solvent 140 Still.

Soil borings in the vicinity of SWMU Number 3, the Solvent 140 Recovery Still were performed because of visual staining and the proximity of the expansion joint to the still.

#### **SWMU Number 6, Waste Water Treatment Facility**

SWMU Number 6, the waste water treatment facility includes 6a, the waste water treatment system, 6b, the above-ground waste water sludge tank, and 6c, the former waste water sludge underground storage tank which has been removed. The waste water treatment system consists of four 3,000-gallon, above-ground waste water tanks, one for processing waste water and the remaining three for storing waste water prior to treatment. The above-ground waste water sludge tank is a 10,000-gallon storage tank used to store non-hazardous sludge generated by the waste water treatment system. The former waste water treatment sludge underground storage tank was removed in 1992 under IDNR supervision and was not part of this inspection.

The room containing the waste water treatment system and the above-ground waste water sludge tank has a concrete floor and masonry unit walls. The room is below grade so the exterior walls are constructed of concrete until they are above grade where the masonry units begin. The room consists of a section of original construction supplemented by a room expansion which caused a joint in the floor. The joint is tight and does not contain any expansion joint filler material. The joints between the footings for the exterior walls and columns and the floor slab have a preformed expansion joint filler.

The area outside of the waste water treatment room was inspected for visual staining, but none was evident. The partial below-grade construction of the waste water treatment room would make it highly unlikely that staining would be evident.

Because of the proximity of the expansion joint to the tank locations, HLA performed the soil boring program in the vicinity of SWMU Number 6.

#### **SWMU Number 12, Sound Lab Used Oil Sump**

The sound lab is a semi-detached building where transmissions are tested. The building has a concrete foundation and floor slab and metal panel siding walls. Concrete trenches within the floor slab collect used oil from the transmission test stands. A metal lined catch basin also is located beneath a test stand to collect used oil. Used oil flows to a collection sump for subsequent removal and treatment.

According to George Charbonneau, the Site Plant Engineer, the floor slab at the sound lab is approximately 36 inches thick. The surface of the slab is sound with no evidence of deterioration that could lead to potential migration pathways. The joints between the metal catch basin and sump and the concrete around them are tight and do not appear to be a potential migration pathway. The floor and wall intersections have been caulked to prevent migration between the floor and wall interface.

Based on the soundness of the concrete, the lack of expansion joints or cracks, and the absence of visual staining, HLA did not perform soil borings in the vicinity of SWMU 12.

#### **SWMU Number 13, Used Oil Storage Tank**

The used oil storage tank, SWMU Number 13, is a 8,200 gallon steel storage tank used to store used oil from the test stands. The tank is located in the same room as the waste water treatment facilities, therefore it has the same containment features. The section on SWMU Number 6, the waste water treatment facility has a description of the room and a discussion of the condition of the concrete.

As described in the section on SWMU 6, because of the proximity of the expansion joint at the exterior wall and floor slab intersection, soil borings were performed at this SWMU.

#### **SWMU Number 14, Used Oil Filtration System**

SWMU Number 14, the used oil filtration system is located in the same room as SWMU Number 3, the Solvent 140 recovery still, therefore it has the same containment features. The used oil filtration

system is a series of filters for removing solids from used hydraulic oil and four, 300-gallon steel tanks for storing the used oil. A metal pan is located beneath the filtration system to catch oil drips.

The concrete in the vicinity of the used oil filtration system is sound. There are expansion joints with preformed expansion joint fillers. It is unknown whether there are water-stops within the expansion joints. The floor in the vicinity of the used oil filtration system has an epoxy coating and is stained with hydraulic oil. It is unknown whether this staining is due to used oil or new hydraulic oil.

Based on the evidence of visual staining and the location of expansion joints near the used oil filtration system, HLA performed the soil borings in the vicinity of SWMU Number 14.

#### **SWMU Number 15, Oil Collection Pans and Catch Basins**

SWMU Number 15 consist of hydraulic oil collection pans or catch basins that are below test stands within the Test Stand Production Area. The size of the collection pans and catch basins vary. Each test stand and it's collection pan or catch basin is identified by a unique asset number. In the DCQAP the following test stand assets were identified to be included within this investigation.

- Oil Collection Pans for Asset Numbers 0109, 1010, 1011, 1106, 1107, 1108, 1128, 1138, 4896, 6045, 6150, 6206, 6213, 6320, 6755, and 7025 (16 assets)
- Catch Basins for Asset Numbers 6475 and 6476

At the time of the inspection, it was apparent the Assets 1010 an 1011 were incorrectly identified and should have been listed as 1110 and 1111. Assets 6150 and 6213 had the oil collection pans removed and were not included with the inspection. Additional Assets numbers 6318 and 6319 were identified and inspected.

Many of the Test Stand Assets are designed to be moveable to allow for a modular layout of the testing facility. This allows Sauer-Sundstrand the ability to improve productivity as necessary. However, at the time of the inspection, the location of an oil collection pan only gives an indication of the current collection performance. If current collection performance is adequate, this gives reason to infer that past performance at a different location within the test stand area was similar; however, past collection performance and associated release migration potential can not be ascertained. The overall capability of the floor within the test stand area to provide containment is discussed since some of the test stand assets have been moved.



The floor of the Test Stand Production Area is reinforced concrete with an epoxy coating. In general, the production area is well maintained and clean for an industrial facility. Due to the nature of the testing process, hydraulic oil is spilled on the floor or drips from parts waiting to be assembled or tested. The epoxy coating on the floor is black. Since the floor is routinely exposed to oil, it is difficult to identify a potential release from staining on the floor. A release must therefore be evaluated based on potential release pathways to the soil beneath the floor. The floor is sound and the epoxy coating covers the entire production area except for localized damaged areas. In the areas identified and inspected where the epoxy coating was missing, the concrete surface beneath was sound and smooth and likely to provide a barrier to a release. There were no potential releases identified through inspection of the interior of the Test Stand Production Area.

An inspection of the exterior of the building identified visual staining along the concrete beneath the walls on the west side of the building. This is the area where the two catch basin assets, 6475 and 6476, are located. A previous release of hydraulic oil from 6475 was identified and remediated in 1989. It is not clear whether the existing staining is due to the previous spill or any current release migration. Due to the presence of visual staining on the floor slab on the exterior of the building, HLA performed soil borings at SWMU 15.

In summary, the results of the inspection indicated the need for soil sampling and analysis beneath SWMUs 3, 6, 13, 14, and 15, and that sampling at SWMUs 2 and 12 was not necessary.

### **3.3 Background Soil Borings**

On September 9, 1993, two soils borings were drilled and sampled at a location near the background monitoring well MW-1 (Figure 4) to obtain data on metals concentrations in native soil at the Site. The borings (BACK-101 and BACK-102) were drilled to a depth of 16 feet bgs. Two soil samples per boring were submitted for analysis of the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) for total analysis and by Toxicity Characteristic Leaching Procedure (TCLP). Soil drilling, sampling and logging procedures were in accordance with the Project Plans, and are summarized in Section 3.4.

### **Geologic Conditions**

Based upon the results of HLA's investigation, the shallow geology around MW-1 is interpreted to consist of primarily clayey soils to the maximum depth drilled (16 feet bgs). Groundwater was not encountered to the maximum depth drilled. No elevated photoionization detector (PID) readings were

measured while drilling BACK-101 or BACK-102. Soil boring logs and soil core photographs are included in Appendixes G and H.

### **Analytical Results**

None of the eight RCRA metals were detected by the TCLP method in the four soil samples analyzed. Analytical data from the background location is included in Appendix I.

Four background metals were detected in total concentration analysis: arsenic, barium, chromium and lead (Table 1). Arsenic was detected in one sample at a concentration of 2.980 milligrams per kilogram (mg/kg), barium, chromium and lead were detected in all four samples and ranged in concentration from 57.100 to 98.400 mg/kg, 8.500 to 11.700 mg/kg, and 4.000 to 4.700 mg/kg, respectively. Data published by the U.S. Geological Survey (USGS) reported mean concentrations of arsenic, barium, chromium and lead at 7.0, 670, 56 and 20 micrograms per gram ( $\mu\text{g/g}$  - equivalent to parts per million), respectively. This data is for the eastern United States which is defined as the part of the United States east of the 96th meridian (USGS, 1984). The metals concentrations detected in soil are less than these published averages. The USGS data is included in Table 1.

### **3.4 SWMU Soil Borings**

A total of 10 soil borings were drilled around five SWMUs in September 1993. Two soil borings were drilled adjacent to SWMU 3 and SWMU 14, four soil borings were drilled adjacent to SWMU 4, two soil borings adjacent to SWMU 6 and 13, and two soil borings adjacent to SWMU 15. Boring locations are shown in Figure 4. All 10 borings were drilled to a depth of approximately 16 feet bgs. Soil drilling, sampling and logging procedures were in accordance with the Project Plans and are summarized below.

Soil sampling during the SWMU and background soil boring program consisted of a split-spoon sampler driven inside of the hollow-stem auger to collect samples at two-foot intervals. Stainless steel liners, segmented into 6-inch sections, were inserted into the split-spoon to minimize the loss of VOCs from the soil samples. Upon retrieval, the split-spoon sampler was opened and screened with a PID. The PID reading was recorded on the soil boring log. Soil samples were selected for VOC analysis based upon the highest PID value for each 6-inch segment. Care was taken to avoid the submission of reworked borehole slough material for chemical analysis. Each end of the 6-inch segment was covered with a Teflon<sup>®</sup> cap and sealed with chemically inert tape. Selected samples were submitted to a qualified laboratory capable of performing SW-846 Method 8260.

Soil sample identification numbers are explained with the following example:

94-AMSS1-1

Where, 94 (year) AM (Ames Site) SS1 (soil sample number 1) 1 (first sampling event). Actual soil sample numbers and the associated soil boring data are summarized in Tables 1 and 2.

Following collection, the samples were placed in an ice-chilled cooler. The samples were shipped via overnight courier with chain-of-custody documentation to Environmental Service Group (ESG) of Indianapolis, Indiana, for chemical analysis. Soil cuttings and other investigation-derived waste were containerized pending evaluation of analytical results. Soil borings were grouted upon completion of drilling.

**3.4.1 SWMU 3 - Solvent 140 Recovery Still and SWMU 14 - Used Oil Filtration System**

SWMU 3, the Solvent 140 Recovery Still and SWMU 14 - the Used Oil Filtration System are located in the same room. Due to the presence of several underground utilities in the area of SWMU 3, possible borehole locations were cleared using ground penetrating radar prior to conducting the intrusive investigation. The letter report from the geophysical subcontractor is included in Appendix J. The soils investigation at SWMUs 3 and 14 consisted of two soil borings (SWMU3-101 and SWMU3-102) drilled to a depth of 16 feet bgs. Two investigative soil samples and one soil duplicate were submitted for analysis of volatile organic compounds (VOCs) by USEPA Method 8260 from SWMU3-101.

**Geologic Conditions**

Based upon the results of HLA's investigation the shallow geology near SWMUs 3 and 14 is interpreted to consist of sandy fill to a depth of four to seven feet bgs overlying lean to fat clay to the maximum depth drilled (16 feet bgs). Water was encountered near the base of the sand fill at approximately seven feet bgs in the sandy fill. Photoionization detector (PID) readings were measured while drilling. At SWMU3-101 the maximum PID detection was 37 meter units at approximately 6 feet bgs, and at SWMU3-102 the maximum PID detection was 999 meter units (off-scale) at approximately 7 to 8 feet bgs.

**Analytical Results**

No VOCs were detected in the three soil samples analyzed from SWMUs 3 and 14.

### 3.4.2 SWMU 4a - Acid Neutralization Sump and SWMU 4b - Cyanide Holding Basin

SWMU 4 was believed to consist of two units that were previously closed: 4a - the acid neutralization sump, and 4b - the cyanide holding basin. Early in the RFI fieldwork, HLA attempted to accurately locate SWMUs 4a and 4b with the help of the Sauer-Sundstrand Plant Engineer, Mr. George Charbonneau. Interviews conducted by Mr. Charbonneau with current and former plant personnel indicated that SWMU 4b, the cyanide holding basin, likely was never installed.

Using a small steel rod and a hammer, HLA was able to locate SWMU 4a, but SWMU 4b could not be located. Ground penetrating radar (GPR), and electrical conductivity were used to evaluate the presence of SWMU 4b. The results of the geophysical survey located SWMU 4a, but indicated that SWMU 4b is apparently not present in the area of SWMU 4a. The geophysical letter report is presented in Appendix J.

The soils investigation at SWMU 4a-the acid neutralization sump, consisted of four soil borings (SWMU4a-101 through SWMU4a-104) drilled to a depth of 15 feet bgs. Two investigative soil samples per boring were submitted for VOC analysis by USEPA Method 8260, and the eight RCRA metals by TCLP and total analysis. Selected soil samples were measured for pH in the field or submitted to the laboratory for pH analysis. Two soil duplicate samples for SWMU 4a were submitted for VOC analysis by USEPA Method 8260, and the eight RCRA metals by TCLP and total analysis.

#### Geologic Conditions

Based upon the results of HLA's investigation the shallow geology around SWMU 4a consists of the following:

Average Depth Interval (feet)	Soils Description
0-4	Fill: Brown to Black Clayey Silt/Silty Clay (ML/CL) moist, soft, low plasticity
4-11	Fill: Brown Poorly Graded Sand (SP) moist to wet, petroleum odor noted, sump backfill
11-16 (maximum depth explored)	Clay: Gray Clay (CL/CH) moist, soft, medium to high plasticity

Water was typically encountered at four to seven feet bgs in the sandy fill material adjacent to the acid neutralization sump. Petroleum odors were noted in the soil cuttings and samples from the sandy fill, though only very low PID readings were measured (0.0 to 0.3 meter units).

## Analytical Results

### Organic

Only two VOCs (carbon disulfide and toluene) were detected in the ten soil samples analyzed for VOCs from SWMU4a. Carbon disulfide was detected in boring SWMU4a-104 in the sample from 9.5 to 10.0 feet bgs at a concentration of 5.3 micrograms per kilogram ( $\mu\text{g/kg}$ ), and toluene was detected in soil boring SWMU4a-101 in the sample from 12.0 to 16.0 feet bgs at a concentration of 7.2  $\mu\text{g/kg}$ . Table 2 presents tabulated VOC data for SWMU 4a.

### Inorganic

None of the eight RCRA TCLP metals were detected in the ten soil samples analyzed.

Four metals were detected in total concentration analysis: arsenic, barium, chromium and lead. Arsenic was detected in three samples and ranged in concentration from 2.480 to 3.010 milligrams per kilogram (mg/kg), barium was detected in five samples and ranged in concentration from 68.5 to 84.0 mg/kg, chromium and lead were detected in all ten samples analyzed at concentrations ranging from 2.5 to 10.7 mg/kg, and 0.647 to 5.100 mg/kg, respectively. Table 1 presents tabulated metals data for SWMU 4a. The four metals detected (arsenic, barium, chromium and lead) in total concentration analysis are for the most part within the range of the metals detected in background soil sample analysis at the Site.

### pH

Seven soil samples were analyzed for pH (Table 3). Soil pH values ranged from 8.72 to 9.51 standard units.

### **3.4.3 SWMU 6 - Wastewater Treatment Units and SWMU 13 - Used Oil Storage Tank**

SWMU 6 consists of two units : 6a - the Wastewater Treatment System and 6b - the Above Ground Wastewater Sludge Tank. Located in the same room as SWMU 6 is SWMU 13 - the Used Oil Storage Tank. The soils investigation at SWMUs 6 and 13 consisted of two soil borings (SWMU6-101 and SWMU6-102) drilled to a depth of 16 feet bgs. Two investigative soil samples per boring were submitted for analysis of VOCs by USEPA Method 8260. One soil duplicate sample from boring SWMU 6-101 was submitted for VOC analysis by USEPA Method 8260.

### Geologic Conditions

Based upon the results of HLA's investigation the shallow geology around SWMUs 6 and 13 is interpreted to consist of the following:

Average Depth Interval (feet)	Soils Description	
0-4	Fill:	Gray to Light Brown Silty Clay (CL) moist, soft, low plasticity
4-8	Clay:	Gray to Light Brown Silty Clay/Clayey Silt (CL/ML) moist, soft, no to low plasticity
8-9	Sand:	Dark Gray Silty Sand/Clayey Sand (SM/SC) moist to wet
9-16 (maximum depth explored)	Clay:	Gray Clay (CL) moist, soft, medium to high plasticity

Water was encountered at approximately eight feet bgs in the silty sand/clayey sand. No PID readings above background were measured during drilling of SWMU6-101 or SWMU6-102.

### Analytical Results

Only one VOC (trichloroethene [TCE]) was detected in one of the four soil samples analyzed for VOCs from SWMUs 6 and 13. TCE was detected in boring SWMU6-102 in the sample from 4.5 to 5.0 feet bgs at a concentration of 9.7 µg/kg.

#### 3.4.4 SWMU 15 - Oil Collection Pans and Basins

The soils investigation at SWMU 15 consisted of two soil borings (SWMU15-101 and SWMU15-102) drilled to depths of 16 and 20 feet bgs, respectively. Two investigative soil samples per boring and one soil duplicate from SWMU 15 were submitted for analysis of VOCs by USEPA Method 8260.

### Geologic Conditions

Based upon the results of HLA's investigation the shallow geology near SWMU 15 is interpreted to consist of sandy fill to a depth of approximately 8-feet bgs overlying lean to fat clay to the maximum depth drilled (16 feet bgs). Water was encountered at a depth of approximately 3-feet bgs in the sand backfill. Elevated photoionization detector (PID) readings and a hydraulic oil odor were noted while drilling at SWMU15-102. No PID readings above background were encountered at SWMU15-101. The maximum PID detection at SWMU15-102 was 7.6 meter units at approximately 7- to 8-feet bgs.

### Analytical Results

Only one VOC (methylene chloride) was detected in one of the five soil samples analyzed for VOCs from SWMU 15. Methylene chloride was detected in boring SWMU15-102 in the sample from 6.0 to 8.0 feet bgs at a concentration of 5.7  $\mu\text{g/kg}$ . The compound detection was qualified with a 'B,' meaning it was attributed to laboratory or field sampling contamination.

### 3.5 South Soil Borings

A total of 14 soil borings were drilled south of the plant to characterize geologic conditions and evaluate potential groundwater migration pathways. Seven of the borings were drilled onsite, north of the CNW railroad tracks, and seven of the borings were drilled offsite, south of the CNW railroad tracks. Two investigative soil samples per boring were submitted for analysis of VOCs. Depths of soil samples are presented in Table 2. All 14 borings were drilled to a depth of approximately 30 to 35 feet bgs. Soil drilling, sampling and logging procedures were in accordance with the Project Plans, and are outlined below.

The 14 soil borings were drilled to an approximate depth of 30 to 35 feet bgs using the hollow-stem auger technique (Driscoll, 1986). Soil borings were placed both north and south of the southern Site property boundary as shown on Figure 4. Sundstrand obtained approval from the property owners to perform these offsite activities south of the Site. Soil samples were collected using a five-foot continuous sampling device (soil sampler) to identify discrete zones of sand potentially present south of the Site. Using this method, the sample is collected in a core barrel which is secured into the lead auger by the drilling rod. The soil sample is then retrieved by extracting the rod, removing the five-foot sample barrel and opening the instrument which is constructed similarly to a split-spoon. After retrieval from the borehole, the soil sampler was opened and its contents screened with a PID to monitor for VOCs. PID readings were recorded by an onsite HLA geologist on the boring log at each drilling location. After the sample was screened, the sample was classified in accordance with the Unified Soil Classification System (USCS). Soil samples were photographed as supportive documentation of subsurface conditions.

Soil samples were selected for laboratory analysis from the south soil borings based primarily upon PID response. Two samples from each boring were selected. If no VOCs were detected by the PID in a boring, one sample for analysis was taken from near the bottom of the boring, and the other was taken from an intermediate depth as determined by the field personnel based on existing knowledge of the Site.

Following collection, the samples were placed in an ice-chilled cooler. The samples were shipped via overnight courier with chain-of-custody documentation to Environmental Service Group (ESG) of Indianapolis, Indiana. Soil cuttings and other investigation derived waste were containerized pending evaluation of analytical results. Soil borings were grouted upon completion of drilling.

Equipment that came in contact with potentially contaminated soil or water was decontaminated prior to and after use. Decontamination consisted of steam cleaning (high pressure, hot water washing) or phosphate-free detergent wash, and distilled, or clean water rinse, as appropriate.

Drilling and sampling equipment was decontaminated as follows:

- Downhole equipment on drill rigs, such as augers, drill rods, and drill bits, as well as parts in contact with fluids, such as mud tanks and sand separators, was steam cleaned prior to use at the drill Site. Visible soil was removed at this time.
- Soil sampling equipment (e.g., split-barrel or standard penetration samplers) was cleaned prior to each use and between sampling. The sampler was steam cleaned or washed in a phosphate-free detergent solution and rinsed in tap water. Visible soil was removed at this time. Wash solutions and rinse water were replaced prior to beginning each boring.
- Steel tapes, well sounders, transducers, and water quality probes were rinsed in distilled water and wiped clean after each use. Generally, only the wetted end of these devices required cleaning.

### **Geologic Conditions**

In general, subsurface material encountered in the south soil borings was clayey soils to the maximum depth drilled (35 feet bgs). Thin, isolated, wet sand seams were found within the clayey soils. Soil borings logs were used to create two cross-sections (Figures 5a and 5b) and a fence diagram (Figure 6).

### **Analytical Results**

Only three compounds (methylene chloride, 1,1,1-TCA, and total xylenes) were detected in the 44 soil samples analyzed as part of the south soil boring program. Methylene chloride was detected in 11 samples at concentrations ranging from 5.0 to 10.0 µg/kg. The methylene chloride detections were qualified with a B, meaning the detection was attributed to laboratory or field sampling contamination. Methylene chloride was detected in the environmental sample at a concentration less than ten times the amount in the associated internal or external blanks. Methylene chloride is a common laboratory artifact.



1,1,1-TCA was detected in three samples at concentrations ranging from 7.2 to 12.0  $\mu\text{g/kg}$ . These samples were collected from soil borings SOUTH-105 (6.5 to 7.0 feet bgs), SOUTH-106 (13.5 to 14.0 feet bgs) and SOUTH-110 (29.0 to 30.0 feet bgs). Total xylenes were detected in two samples at concentrations of 7.3 to 14.0  $\mu\text{g/kg}$  from soil boring SOUTH-110 from depths of 16.5 to 17.0 feet bgs and 29.0 to 30.0 feet bgs.

### **3.6 Laboratory Program and QA/QC**

#### **3.6.1 QA/QC Samples**

The laboratory containers and sample collection/handling procedures were quality checked with one equipment blank for every day of sampling (i.e., 10% of the total number of samples collected in a field day) that was analyzed for VOCs and metals, where appropriate, and one trip blank for every cooler that was analyzed for VOCs. QA/QC VOC sample data is presented in Table 4.

#### **3.6.2 Analytical Methods**

The September 1993 soil, sediment, and surface water organic and inorganic Phase I analytical results were evaluated to assess the accuracy, precision, completeness, and validity of the data. The analytical laboratory, Environmental Service Group, of Astbury Gabriel Corporation (ESG), of Indianapolis, Indiana, utilized USEPA Method 8260, a purge and trap, gas chromatographic/mass spectrometric method for analysis of volatile organic compounds (VOC). Inorganic analysis was conducted using inductively coupled plasma atomic emission spectroscopy (USEPA Method 6010) for analysis of antimony, barium, cadmium, chromium, copper, nickel, silver, and zinc; atomic absorption spectroscopy utilizing a graphite furnace technique for analysis of arsenic (USEPA Method 7060), beryllium (USEPA Method 7091), lead (USEPA Method 7421), and thallium (USEPA Method 7841); atomic absorption spectroscopy utilizing the cold-vapor technique for analysis of mercury (USEPA Method 7471); and ultraviolet colorimetry for the analysis of cyanide (USEPA Method 9012).

#### **3.6.3 Data Validation Methods**

To validate the data, sample collection documentation and laboratory quality control (QC) records were reviewed. Specifically, field notes and chain of custody documentation; the analytical methods used; sample holding times; initial and continuing instrument calibration data; and internal and external blank results were reviewed. Accuracy and precision of the data was evaluated by review of the surrogate (where appropriate), laboratory control sample (LCS), matrix spike (MS), and matrix spike duplicate (MSD) recoveries, as available; review of duplicate sample analyses; and comparison of

this data to laboratory and USEPA established limits (USEPA 1986) and guidelines (USEPA 1988a and 1988b).

### **3.6.4 Data Validation Results**

#### **General QC Considerations**

Available QC information indicated that the samples were collected, preserved, and transported properly; appropriate analytical methods were utilized and the analyses were conducted within USEPA established holding times (USEPA, 1986). Mass Spectrometer tuning information and initial and continuing calibration data indicate that the analytical instruments were calibrated properly at the time of analysis. This data also documented that the analyses were conducted within the linear range of the instrumentation used.

#### **Accuracy**

With the exception of the three VOC analyses discussed below, surrogate (where appropriate), LCS, and MS recovery data indicated that all analyses met established laboratory or USEPA (USEPA, 1986) acceptance criteria for accuracy. Because of low surrogate recovery (indicative of poor analytical accuracy), the VOC results (Table 5) for surface sediment samples 93-AMSD95-1, 93-AMSD97-1, and the duplicate of sample 93-AMSD97-1 (93-AMSDDUP97-1) were qualified as estimated.

#### **Precision**

Available QC data suggest that the analyses are precise. Typically, MS duplicate pairs are evaluated to assess if the data meet established precision criteria. However, in accordance with the USEPA-approved Project Plans, site-specific MSDs were not analyzed. In the absence of this data, a review was conducted of the 14 Site sample duplicate pairs, duplicate laboratory analyses conducted on the same non-spiked sample, and analysis of MS/MSDs prepared from samples collected by other investigators at other sites but that were analyzed in the same analytical batches as the Site samples.

#### **Laboratory or Field Contamination**

All method, trip, and equipment blank analytical results were reviewed for the presence of target compounds. The concentration of compounds detected in the blanks was compared to the concentration of these compounds detected in the associated environmental samples. In instances in which the concentration of a VOC detected in an environmental sample was less than 10 times (for common lab artifacts) or 5 times (for all other target compounds) the amount detected in the associated blanks, the environmental sample result (Table 2) was flagged to indicate that the detection

could be attributed to laboratory or field sampling contamination. For the VOC analysis, 70 percent of the detections of common VOC laboratory artifacts (acetone, methylene chloride, 2-butanone, and toluene [USEPA, 1988]) that were quantified, or reported as present below quantification limits (BQL), were attributed to laboratory or field sampling contamination. For all other VOC target compounds, only 3 percent of the detections were attributed to laboratory or field sampling contamination. No inorganic compound detections were attributed to laboratory or field sampling contamination.

#### **Completeness and Validity**

The completeness of the analytical data is defined as the percentage of the analytical results that are considered valid. USEPA guidelines (USEPA, 1988a and 1988b) indicate that data sets should be at least 80 percent complete. Based on the QC data reviewed, all data are valid and therefore the data sets are 100 percent complete.

## **4.0 PHASE II INVESTIGATION**

This section presents the methodology and results of the Phase II Investigation. The Phase II Investigation included surface water and sediment sampling and analysis (Section 4.1), monitoring well replacement (Section 4.2), groundwater sampling and analysis (Section 4.3), and hydraulic conductivity testing (Section 4.4).

### **4.1 Surface Water and Sediment Sampling and Analysis**

#### **4.1.1 Methods**

This section describes the basic technique for the collection of water and sediment samples from the drainage ditch just south of the plant. The drainage ditch transfers runoff from adjacent Interstate 35 and the plant to the flood control basin. The base of the drainage ditch consists mainly of indigenous silt and clay. Sampling locations are shown in Figure 3.

The surface water and sediment sampling was conducted on September 20, 1993. At four locations surface water and sediment samples were collected (SW/SED02, SW/SED03, SW/SED04 and SW/SED05), and at four locations only sediment samples were collected (SED01, SED06, SED07 and SED08).

The surface water samples were collected at the deepest point of water in the ditch. These samples were collected by slowly lowering a Teflon<sup>®</sup> bailer into the ditch to a depth just above the ditch floor. The bailer was then removed slowly and a discharge spout was inserted into the base of the bailer. The collected water was then used to fill the appropriate laboratory containers. Indicator parameters (pH, specific conductivity, and temperature) were measured in the field and recorded in the field logbook.

The sediment samples were collected using a stainless steel trowel. The sediment was obtained by scraping the trowel along the base of the ditch until enough material for laboratory analysis was retrieved. The sampler was lifted out of the water carefully so that little agitation or sediment loss occurred. The sediment was then transferred directly from the trowel into appropriate laboratory jars.

Both total and dissolved surface water samples were collected for metals analysis. Filtration of the dissolved samples was performed using a peristaltic pump and a 0.45 micron filter. Both total and

dissolved surface water samples collected for metal analysis were preserved in the same manner as groundwater samples.

Sample containers were labeled with the following information:

- Sample identification,
- Samples location,
- Date and time,
- Sample collector, and
- Analytical procedures requested.

A chain-of-custody record was kept for samples collected and every bottle was clearly marked with a waterproof label. The chain-of-custody record provides identification including the sample collector, the date, time, and location of the collection point. Other information such as weather and flow conditions were also noted and recorded in the logbook.

Sediment sample location SED01 is located at the location of a culvert that allows surface water to enter the Site under Interstate 35, sediment/surface water sample location SED02 is located in the drainage ditch approximately 850 feet downstream from SED01 sample location. Sediment/surface water sample location SED/SW03 is located at the Sauer-Sundstrand drainage outfall.

Sediment/surface water sample location SED/SW04 is located approximately 300 feet downstream from SW03. Sediment/surface water sample location SED/SW05 is located approximately 400 feet downgradient of sediment sample location SED04. Sediment sample locations SED06 and SED07 are located in the flood control basin, and sediment sample location SED08 is located at the east end of the culvert that drains the flood control basin offsite to the west. Surface water and sediment sample locations are shown on Figure 3. Surface water samples were submitted for analysis of VOCs by USEPA Method 8260, and total and dissolved priority pollutant metals. Sediment samples were analyzed for VOCs and priority pollutant metals for total and TCLP analysis. Analytical results for sediment sample data are presented in Tables 5 and 6. Analytical results for surface water data are presented in Table 7.

#### 4.1.2 Surface Water Analytical Results

##### Organic

No VOCs were detected above the quantitation limit in the four surface water samples analyzed. The raw analytical data is included as Appendix K.

##### Metals

###### Total

Four metals were detected in at least one or more of the four surface water samples analyzed for total metals. Arsenic, barium and lead were detected in sample SW-04 at 0.013 mg/L, 0.443 mg/L, and 0.0143 mg/L. These are the only detections of arsenic and lead in surface water at the Site. Sampling locations are shown in Figure 3.

Zinc was detected in samples SW-03 and SW-04 at 0.020 and 0.304 mg/L, respectively. Sample SW-03 is located at the Sauer-Sundstrand drainage outfall. Sample SW-04 is located approximately 300 feet downstream from SW-03.

###### Dissolved

Only one metal (zinc) was detected at one location (SW-03) of the four surface water sample locations analyzed for dissolved metals. Zinc was detected at 0.020 mg/L at SW-03. The dissolved zinc concentration is the same as the total zinc concentration, indicating that zinc is present in an almost completely dissolved form.

##### Field Parameters

Water samples were measured in the field for pH, temperature and specific conductivity. Results are reported on Table 7. The pH ranged from 6.85 to 8.09 standard units, the temperature ranged from 61 to 83°F (16.0 to 28.2 Centigrade), and specific conductivity ranged from 392 to 590 micromohs per centimeter (umhos/cm). The highest pH, temperature and specific conductivity was detected at the SW3 sample location which is the location of a Sauer-Sundstrand drainage outfall.

#### 4.1.3 Sediment Analytical Results

##### Organic

Seven VOC compounds were detected above the quantitation limit in the eight sediment samples analyzed. The seven VOCs detected are methylene chloride, chloromethane, acetone, 1,1-dichloroethane (1,1-DCA), 2-butanone, cis-1,2-dichloroethene (cis-1,2-DCE) and toluene.

Methylene chloride was detected in three samples at concentrations ranging from 5.5 to 14.0  $\mu\text{g/kg}$ . The methylene chloride detections were qualified with a B, meaning the detection was attributed to laboratory or field sampling contamination. Methylene chloride is a common laboratory artifact.

The other six VOCs were detected once each at two sediment sample locations SED-05 or SED-07. At the SED-05 sample location 1,1-dichloroethane was detected at 6.9  $\mu\text{g/kg}$ , and cis-1,2-dichloroethene was detected at 6.8  $\mu\text{g/kg}$ . Both of these detections were qualified with a J, meaning they are estimated values.

At SED-07 sample location chloromethane was detected at 12  $\mu\text{g/kg}$  (duplicate analysis), acetone was detected at 28  $\mu\text{g/kg}$ , 2-butanone was detected at 11  $\mu\text{g/kg}$ , and toluene was detected at 8.7  $\mu\text{g/kg}$ . All of these detections were qualified with a B, meaning the detection was attributed to laboratory or field sampling contamination.

#### Inorganic

Zinc was the only metal detected in the eight sediment samples analyzed by the TCLP method. Zinc was detected in all eight sediment samples by the TCLP method. Zinc concentrations ranged from 0.160 to 1.84 milligrams per liter (mg/L). Zinc concentrations were typically less than 0.60 mg/L, with only one sample (SED-04) greater than that concentration.

Five metals (barium, copper, chromium, lead and zinc) were detected by total concentration analysis in sediment at the Site. Lead and zinc were detected in all samples and ranged from 1.42 to 22.40 mg/kg, and 12.0 to 133.0 mg/kg, respectively. Chromium and copper were detected in all but one of the sediment samples analyzed and ranged in concentration from 3.40 to 12.60 mg/kg, and 9.2 to 43.0 mg/kg, respectively. Barium was detected at five of the seven sediment sampling locations and ranged in concentration from 61.40 to 81.60 mg/kg. The metals detected in total concentration analysis are for the most part within the range of metals detected in background soil sample analysis at the Site.

Data published by the USGS reported mean concentrations of barium, copper, chromium, lead and zinc at 670, 27, 56, 20 and 65  $\mu\text{g/g}$  (equivalent to parts per million), respectively. This data is for the eastern United States which is defined as the part of the United States east of the 96th meridian (USGS, 1984). The metals concentrations detected in soil are less than these published averages. The USGS data is included in Table 6.

## 4.2 Monitoring Well Replacement

Eight monitoring wells were identified for replacement in the Project Plans. These wells were: MW-2S, MW-2D, MW-6S, MW-6D, MW-13, MW-14, MW-17 and MW-30. These wells required replacement due to either previous removal for DDSA/ISCSA closure activities, or improper well construction or design, as described in the Project Plans.

During the September 1993 field activities, two wells (MW-2S and MW-2D) were closed, and replaced with MW-R2S and MW-R2D.

During the August 1994 field activities six soil borings were drilled; five of them were converted into groundwater monitoring wells (MW-R6S, MW-R13, MW-R14, MW-R30, MW-R17). Boring MW-R6D was not converted into a groundwater monitoring well because groundwater was not encountered between 60 and 90 feet bgs (intended approximate well screen depth). Boring logs and groundwater monitoring well construction diagrams are presented in Appendix G.

### 4.2.1 Drilling Methods

The drilling procedures and well installation and construction techniques were in accordance with the procedures described in the Project Plans. The final monitoring well locations were placed based on accessibility and other physical obstructions; however, they were located within the proposed areas. A summary of the groundwater monitoring well information is presented in Table 8.

An HLA geologist supervised well installation, observed drilling, collected soil samples for chemical analysis, and prepared lithologic logs of borings. Drilling and well installation methods varied according to the type and depth of the intended monitoring well. At most replacement well locations, single-cased wells (MS-R25, MW-R20, MW-R6S, MW-R13, MW-R14, and MW-R30) were installed and drilled using standard hollow stem augers.

As documented in the Project Plans, improper installation wells in areas of previously identified shallow groundwater contamination could result in the gross contamination of the intermediate aquifer. Two locations, MW-6D and MW-R17 required the double-cased method. Drilling mud was used at these locations to control potential heaving sands.

Soil samples were collected according to soil sampling procedures described below.



#### 4.2.2 Soil Logging

Soils encountered during drilling were classified by an HLA geologist in accordance with ASTM Standard D 2488-84, which is based on the Unified Soil Classification System. For logging, soil cuttings samples were collected at each observed change in lithology or at least every 2.5 feet. For locations requiring mud rotary boring, split-spoon samples were taken at 5-foot intervals after a depth of 30 feet bgs. Observations, which include the following information, as appropriate, were recorded on a standard boring log form:

- Boring or well designation and location;
- Drilling and sampling methods and equipment;
- Names of field geologist and driller;
- Dates and times started and completed;
- Depth where groundwater was first encountered;
- Sample depths and recovery rates;
- Blow counts, if appropriate;
- Color of soils;
- Grain size of soils;
- Descriptive comments;
- Variations in drilling rates and rig behavior;
- ASTM Classification;
- Signature or initials of observer; and
- Depth of standing water in boring, if any, upon completion of boring.

Subsurface soil samples were collected as previously described in Section 3.4 for lithologic description and chemical analysis. The intent of the additional monitoring wells (replacement wells) was to determine the extent of VOC-impacted groundwater. In general, the following are sampling methods that were used:

- For lithologic logging, regardless of the drilling method, cuttings samples were collected at observed changes in lithology. Soil samples for lithologic description were collected by driving a split-barrel sampler 2.5-foot intervals or by using a 5-foot continuous core barrel. Soil samples were examined and classified according to the ASTM System.

- Samples for chemical analysis were generally collected using a split-barrel or continuous core barrel sampler, as appropriate.
- Split-barrel samplers were either hydraulically or mechanically driven with a hand-held or rig-mounted hammer. Continuous core barrels were advanced during drilling.

The wells installed were single-casing wells as described below. Well construction details for each installed well were entered on a field well completion form (Appendix G). All drilling, sampling and well installation equipment and material was decontaminated as described.

### 4.2.3 Well Construction

Single-casing wells that fully penetrate an aquifer were drilled to a minimum of one to two feet into the first aquitard or clay layer below the aquifer. The monitoring well casing and screen (wire-wrapped, factory-slotted) was constructed using 2-inch diameter Schedule 40 flush-threaded PVC. Slot size was determined on the basis of existing data from nearby wells and borings as well as evaluation of the interval screened in each well. When rotary methods were used, centralizers were placed at the top and bottom of the screens. The screen length was 10 feet or less, depending on the geologic material present. When the hollow-stem auger method was used, the casing was set in place by lowering it through the inside of the auger to the proper depth. A sand pack of water-washed sand (sized to be compatible with aquifer materials and screen slot size) was placed adjacent to the entire screened interval and extended at least two feet above the top of the screen. No sand pack was placed that created an interconnection of two or more aquifer zones. When the hollow-stem auger was used, the sand pack was placed by carefully pouring sand down the annulus between the hollow-stem auger and well casing. The hollow-stem augers were raised periodically and an auger flight removed to allow the sand to fill the annulus between the casing and the borehole wall. When the rotary method was used, the sand pack was pumped through a tremie pipe using potable water. Sand levels within the borehole were confirmed by sounding with a weighted tape.

A minimum two-foot thick bentonite pellet seal was placed above the sand pack by gravity free-fall from the surface. The pellets expanded under water to form a tight annular seal above the sand pack. If the bentonite pellet seal was placed above the static water level, a bentonite slurry was used to seal the screened interval. When the hollow-stem auger rig was used, the bentonite seal was placed in the same manner as the sand pack and levels sounded with a weight tape.

The annulus above the bentonite seal was grouted with cement/bentonite grout and mixed with tap (city-supplied) water. The grout was pumped through a tremie pipe, placed near the bottom of the open annulus (approximately two feet above the bentonite seal) to the surface, thereby effectively

sealing the well from the bottom upward. If the bentonite seal was above the static water level, the grouting materials were thoroughly mixed at the surface and carefully poured into the annulus above the bentonite pellet seal to the top of the annular space (ground surface). The following mixing procedure was used for grout to reseal borings and install protective casings and monitoring wells:

- Place water in grout tub; note the volume.
- Start grout pump with intake hose in the grout tub and the output/return hose flowing back to the tub.
- The field geologist estimated the total amount of grout mixture required based on the depth and diameter of the borehole or annular space to be grouted. Then the amounts each of water, Portland cement and bentonite gel required to produce the estimated volume of grout will be determined based on the following ratio:
  - 6 to 8 gallons water
  - 1 cubic feet Portland cement
  - 2 to three pounds bentonite gel
- Slowly add the cement and bentonite with the pump running while agitating the grout tub with the shovel to prevent settling.
- When the grout is thoroughly mixed, attach side-venting tremie tube to the output/return hose and place grout above either bentonite pellets or bentonite gel seal.

Following the mixing of the grout, the project geologist collected a grab sample of the grout in a plastic or paper drinking cup. After being allowed to cure, the sample was inspected and the results recorded in the field log book. The integrity of the sample gave an indication of the integrity of the actual grout seal in the borehole, or protective casing.

Wells were completed using either of two methods. In areas exposed to vehicular or pedestrian traffic, wells were completed below grade using a steel well housing with a locking cover set in the annular cement seal. These wells were surrounded by a steel or reinforced concrete utility box with a steel or concrete traffic cover installed over the wellhead, as appropriate. The utility boxes were set in concrete about one-inch above grade. The concrete was sloped to promote surface-water drainage away from the wells. In areas where wells are not exposed to vehicular or pedestrian traffic, they were completed one- to three-feet above ground surface. An annular cement seal was placed around the well, and the concrete was sloped to promote drainage away from the wells. The above-grade wells were secured with a locking well cover and painted a highly visible color.

For all wells, a locking well cover was set in cement grout. After the grout had set for at least 24 hours, each well was developed as described below. The identification number of each well was

marked on the locking well cover. The top of each well casing was surveyed by a registered land surveyor to obtain elevations relative to the mean sea level (msl) datum to an accuracy of  $\pm 0.01$  feet.

The following methodology was used when constructing monitoring wells in an area where the overlying aquifer was known or suspected of containing VOCs. Monitoring wells MW-R6D and MW-17 were installed using mud rotary techniques with double casing. These procedures were designed to minimize the possibility of cross-contamination between sand units.

An HLA geologist supervised well installation and prepared a lithologic log of the boring using the USCS. The wells were drilled by direct-rotary methods. Bentonite and/or water drilling fluid was used. If soil samples were collected, they were obtained as described in Section 3.4.

Double-cased wells were installed in the following manner: a 12- to 16-inch diameter borehole was drilled approximately two feet (as appropriate) into the aquitard above the aquifer to be monitored. A minimum 8 $\frac{1}{4}$ -inch diameter steel conductor casing was set to the bottom of the borehole and pushed or driven an additional one foot into the aquitard. Centralizers were placed at the top and bottom of the conductor casing. The annular space between the conductor casing and the borehole was then filled from the bottom to the ground surface by pumping cement/bentonite grout through a tremie pipe. The grout was mixed using tap (city-supplied) water. After the grout had set for at least 24 hours, the drilling fluid in the conductor casing was flushed with tap water followed by the drilling of a minimum 8-inch diameter borehole approximately 2 feet (as appropriate) into the aquitard or clay layer beneath the aquifer to be monitored.

The interval to be screened was then selected utilizing available lithologic data from the boring and from nearby wells. The wells were constructed using 4-inch (minimum) Schedule 40 threaded PVC casing and screen. PVC or stainless steel centralizers were placed at the top and bottom of the screen. The screens had factory-milled slots. Slot sizes were determined on the basis of existing data from other wells and borings in the vicinity.

A sand pack of water-washed sand (sized to be compatible with the screen) was then placed adjacent to the entire screened interval and was extended at least two feet above the top of the screen. No screen or sand pack interval was placed that interconnects two or more aquifer zones. A minimum two-foot bentonite pellet seal was placed above the sand pack. Levels of sand and bentonite was confirmed during well construction by sounding with a weighted tape. The annular space above the bentonite seal was sealed by pumping cement/bentonite grout from the bottom of the annular space to the ground surface through a tremie pipe. The grout was mixed using tap (city-supplied) water.

#### 4.2.4 Well Development

After the grout had set for at least 24 hours, each well was developed by surging, or as a last resort, bailing. Bailing was only performed if well development by surging was unsuccessful. Depending on the type of well, one or more of these methods was used. Each well was developed until the discharged water was visibly clear and free of sediment. After surging and/or bailing, a pump was placed near the bottom of the well and pumped at a discharge rate that could be continuously maintained until the water was again visibly clear and free of sediment. The adequacy of well development was determined by the HLA geologist. All well development fluids were contained and stored on site pending the results of chemical analyses.

#### 4.2.5 Chemical Analysis

Two soil samples from MW-R2S were submitted for analysis of VOCs by USEPA Method 8260, the eight RCRA metals by TCLP and total analysis, and cyanide. Two soil samples from MW-R30 were submitted for analysis of VOCs by USEPA Method 8260. No soil samples were submitted for replacement wells within the former DDSA/ISCSA closure area pursuant to an HLA RFI Work Plan Supplement letter dated July 19, 1993 to USEPA (HLA, 1993). This letter was reviewed and accepted by USEPA.

##### Organics

Only one VOC (total xylenes) was detected from the samples analyzed from the MW-2 replacement wells. Total xylenes was detected at 5.9  $\mu\text{g/kg}$  in the soil sample from MW-R2S from 4.0 to 6.0 feet.

Two compounds were detected in the three samples analyzed from the MW-30 replacement well. 1,1,1-TCA was detected in the soil samples from MW-R30 from 6.0 to 7.0 feet and 11.0 to 11.5 feet bgs at 26 and 50  $\mu\text{g/kg}$ , respectively. Additionally, cis-1,2-DCE was detected in the soil sample from 11.0 to 11.5 feet bgs.

##### Metals

None of the eight RCRA metals were detected by the TCLP method in the three soil samples analyzed. Analytical data from monitoring well replacement soil samples is included in Appendix I.

Four metals were detected in total concentration analysis: arsenic, barium, chromium and lead (Table 1). Arsenic was detected in one sample at a concentration of 2.760 milligrams per kilogram (mg/kg), barium, chromium and lead were detected in all three samples and ranged in concentration from 51.000 to 76.000 mg/kg, 8.700 to 9.000 mg/kg, and 3.500 to 4.5200 mg/kg, respectively.

Cyanide was not detected in any of the three samples analyzed.

### 4.3 Groundwater Sampling

#### 4.3.1 Methods

During the September 1994 groundwater sampling event, 29 groundwater monitoring wells were sampled. The groundwater sampling procedures were in accordance with the Project Plans.

Replacement wells (MW-R6D, MW-R13, MW-R14, MW-R17, MW-R30) were developed and surged according to the methods described in the Project Plans. Initially it was attempted to develop the wells by a submersible pump. However, because the wells were recharging at a slow rate they were developed using a stainless steel or Teflon® bailer.

Prior to purging and sampling, water level measurements and total well depths were collected from 30 wells. The air around the well head (top of casing) was monitored using a PID before the sampling procedure was initiated for each well. Each well was then purged of approximately three casing volumes using either a stainless steel bailer or the dedicated bailer for each well. pH, temperature, and specific conductivity were measured initially and then following each volume removal. After purging, water samples were collected using the bailers and transferred to the appropriate containers with the required preservative. For the slow recharging wells, samples were collected as soon as sufficient volume was present in the well casing. If a well was purged dry before three casing volumes were removed, the sample was collected after the well had recovered sufficiently (approximately 80% of the water level above the bottom of the well prior to purging) or 24 hours, whichever occurred first. The samples were handled carefully to avoid the loss of VOCs present in the groundwater. Clean nitrile gloves were used during the sampling procedure. The dissolved priority pollutants metals samples were field filtered. All water samples collected were shipped the same day to ESG for analysis by the USEPA methods for the parameters listed in Section 4.5. It was not possible to sample groundwater monitoring well MW-16 (installed by others in previous investigations) because the bailer could not fit through the well casing.

Sampling equipment was thoroughly decontaminated with distilled water and Alconox™ detergent before sampling each well. Proper preservation and handling techniques were used to prevent sample contamination, loss of VOCs, and to ensure that samples and analyses were representative of groundwater quality at each groundwater monitoring well. Immediately after each sample was collected it was placed in the appropriate container that was provided by ESG, sealed, and put in an ice-chilled cooler. Samples collected for analysis using USEPA method 8260 were preserved with

hydrochloric acid and samples analyzed for total and dissolved priority pollutant metals were preserved with nitric acid. Each container was labeled to include the sample number, HLA job number, monitoring well from which the sample was collected, date and time of collection, and the initials of the sample collectors. The sample identification numbering methodology was (as described in the Project Plans) the following: 94-AMGWR17-1. Where: 94 is the year that the sample was collected, AM is the Ames Site, GWR17 is the groundwater sample from Well MWR-17 and 1 indicates that this was the first sampling event.

Chain-of-custody forms were completed daily to document sample possession from time of collection to laboratory analysis. Each form included the date, time of sample collection, site location, monitoring well from which sample was collected, analysis performed and any other comments that might prove to be useful during the Laboratory analysis. Observations made during the sampling activities were recorded in a site-specific logbook, which was retained by HLA as part of the investigative file.

Decontamination fluids, development and purge water, used personal protective equipment, and other used materials generated during this sampling event were collected and placed in 55-gallon Department of Transportation (DOT) approved drums onsite prior to final disposal, in accordance with the state regulations. Drums were sealed and labeled with the monitoring well number and accumulation date. Development and purge water was containerized only for the wells listed in the Project Plans.

#### **4.3.2 Nature and Occurrence of Groundwater**

Static water levels were measured on September 29, 1994. Groundwater elevations were evaluated (Table 9) based on these measurements. Generally, water levels in the shallow sand ranged from approximately 1.5 to 9.9 feet below ground surface (bgs), and from approximately 5.2 to 43.2 feet bgs in the intermediate sand unit. The elevation data in Table 9 includes casing elevation, stick-up, depth to water from top of casing and ground surface and groundwater elevation. Potentiometric maps were prepared for the shallow sand (Figure 7), and the intermediate sand unit (Figure 8) using these measurements.

Based upon an interpretation of measurements in the shallow sand, groundwater appears to flow toward the south-southwest with wells MW-1 (969.10 msl) located furthest upgradient, and well MW-31 located furthest downgradient onsite (947.15 msl), and well MW-24 located furthest downgradient offsite (941.06 msl). Generally, flow in the shallow sand is to the southwest at a

gradient of approximately 0.014 feet per foot (ft/ft). Overall, the groundwater flow and gradient is consistent with findings in previous sampling events (HDR, 1989).

Groundwater flow in the intermediate sand unit is similar in direction to the shallow sand wells and is toward the south at a gradient of 0.026 ft/ft. In general, the flow direction and gradient is consistent with previous interpretations (HDR, 1989).

#### 4.3.3 Analytical Results

##### Organic

Twelve VOC compounds were detected in at least one or more wells of the 29 sampled. Groundwater VOC results are summarized in Table 10 and Figures 9 and 10. The raw analytical data is included as Appendix L.

Nine chlorinated aliphatic hydrocarbon compounds were detected in at least one or more of the 29 wells sampled. The chlorinated aliphatic hydrocarbons detected include: 1,1-DCE, trans-1,2-DCE, cis-1,2-DCE, 1,1-DCA, 1,1,1-TCA, 1,2-DCA, TCE, 1,1,2-TCA, and PCE.

PCE was detected in 13 wells at concentrations ranging from 6.2 to 2,500  $\mu\text{g/L}$ . The MCL for PCE is 5  $\mu\text{g/L}$ .

1,1,1-TCA was detected in 12 wells at concentrations ranging from 23 to 970  $\mu\text{g/L}$ . Seven wells exceeded the MCL for 1,1,1-TCA of 200  $\mu\text{g/L}$ .

TCE was detected in ten wells at concentrations ranging from 17 to 170  $\mu\text{g/L}$ . The MCL for TCE is 5  $\mu\text{g/L}$ .

1,1-DCA was detected in ten wells at concentrations ranging from 9.6 (estimated) to 560  $\mu\text{g/L}$ . No MCL is established for 1,1-DCA.

1,1-DCE was detected in nine wells at concentrations ranging from 24 (estimated) to 250  $\mu\text{g/L}$ . The MCL for 1,1-DCE is 7  $\mu\text{g/L}$ .

Trans-1,2-DCE was detected in only one well (MW-11) at 7.1  $\mu\text{g/L}$ . The MCL for trans-1,2-DCE is 100  $\mu\text{g/L}$ . Cis-1,2-DCE was detected in 11 wells at concentrations ranging from 7.7 to 730  $\mu\text{g/L}$ . The MCL for cis-1,2-DCE is 70  $\mu\text{g/L}$ . Seven wells exceeded the MCL for cis-1,2-DCE.



1,1,2-TCA was detected in four wells at concentrations ranging from 8.0 to 30 µg/L. The MCL for 1,1,2-TCE is 5 µg/L.

1,2-DCA was detected in only one well (MW-R13) at 5.8 µg/L. The MCL for 1,2-DCA is 5 µg/L.

Acetone was detected in two wells MW-R2D and MW-23 at 25 and 66 µg/L. There is no MCL for acetone. Methylene chloride was detected in one well (MW-R13) at 9.1 µg/L. The MCL for methylene chloride is 5 µg/L. The methylene chloride detections were qualified with a B, meaning the detection was attributed to laboratory or field sampling contamination. Methylene chloride was detected in the environmental sample at a concentration less than ten times the amount in the associated internal or external blanks. Methylene chloride is a common laboratory artifact.

Total xylenes were detected in three wells at concentrations ranging from 7.7 to 16 µg/L. The MCL for total xylenes is 10,000 µg/L.

#### Metals

Groundwater samples from the 29 monitoring wells sampled were analyzed for 14 total and dissolved metals. Four metals were below quantification limits for all 29 wells for both total and dissolved analysis: antimony, selenium, silver and thallium. Groundwater metals results are summarized in Table 11. HLA has used the dissolved groundwater metals data in data evaluation as it is most representative of truly dissolved species concentration (USEPA, 1989c).

Nickel was detected in 12 wells at total concentrations ranging from 0.043 to 1.060 mg/L. Only one well (MW-19) had detectable dissolved nickel at 0.235 µg/L. The MCL for nickel is 0.100 mg/L. Dissolved nickel data reveal nickel MCL was exceeded in MW-19.

### 4.4 Hydraulic Conductivity Tests

#### 4.4.1 Methods

Slug tests in 16 monitoring wells (MW-R2D, MW-R6S, MW-11, MW-12, MW-R13, MW-R14, MW-18, MW-19, MW-21, MW-22, MW-23, MW-24, MW-27, MW-R30, MW-31, and MW-32) were performed during this investigation in accordance with the methods described in the Project Plans. Hydraulic conductivity test data is summarized in Table 12. Two wells (MW-R2S and MW-R17) that did not recover sufficiently in 24-hours were not evaluated. Based on field observations, these two wells did not recover within 80% of the initial water level.

The slug tests were performed after groundwater sampling was completed. An additional benefit to this sequence was that fine-grained material was removed from the well screen during the purging of stagnant water prior to groundwater sampling. This improves the accuracy of the hydraulic conductivity values obtained.

Prior to each aquifer slug test, each well was opened and screened with a PID. The static water level was measured using an electronic water level meter to an accuracy of  $\pm 0.01$  feet. The levels were recorded in the field logbook and used as the reference water elevations for the slug tests. Water levels were monitored during the slug tests using an electronic data logger (Hermit 1000/2 channel) and a pressure transducer (10 psig). The data collected during these tests were electronically transferred to a computer and then used to derive in-situ hydraulic conductivity values using a computer modeling software package called AQTESOLV. Methods developed by Cooper, Bredehoeft, and Papadopoulos (1967) (confined aquifer) for slug test analysis.

Before each slug test, the slug (a PVC cylinder) was cleaned using an Alconox™ wash, followed by a tap water rinse and a final distilled water rinse. The decontaminated solid PVC cylinder was inserted in each monitoring well to conduct falling head tests. Rising head tests were conducted when the cylinder was removed from each well. Measurement of the decreasing water levels is defined as a falling head test, and measurement of the increasing water levels is called the rising head test. The pressure transducer was placed into each well to continuously measure the change in water level, and automatically record them with the data logger. The data logger was programmed to collect data from the transducer in a logarithmic pattern. The measurements were collected in time intervals that were selected based on the expected hydraulic conductivity of the well. For fast recovering wells the intervals were relatively small (1-2 minutes) while for slow recharging wells the intervals increased (4-8 minutes). Completion of the tests was defined as recovery of 90% of the raised/lowered water level. However, in wells with extremely low recharge rates the test was terminated after six to seven hours.

#### 4.4.2 Results

Hydraulic conductivity values for the shallow sand wells ranged between  $1.3 \times 10^{-5}$  and  $1.2 \times 10^{-2}$  cm/sec with an average hydraulic conductivity of  $3.1 \times 10^{-3}$  cm/sec. Hydraulic conductivity values for the intermediate sand unit wells ranged between  $5.3 \times 10^{-7}$  and  $5.3 \times 10^{-5}$  cm/sec with an average hydraulic conductivity of  $1.8 \times 10^{-5}$  cm/sec. Hydraulic conductivity test plots are presented in Appendix M.

#### **4.5 Laboratory Program and Quality Assurance/Quality Control**

##### **4.5.1 QA/QC Samples**

The laboratory containers and sample collection/handling procedures were quality checked with one equipment blank for every day of sampling (i.e., 10% of the total number of samples collected in a field day) that was analyzed for VOCs and total and dissolved metals; one trip blank for every cooler that was analyzed for VOCs; two decontamination water blanks that were analyzed for VOCs and total and dissolved metals; and four duplicate, matrix spike (MS) and matrix spike duplicate (MSD) samples that were analyzed for VOCs and total and dissolved metals. These samples were collected from relatively fast recharging wells (MW-4, MW-31, MW-10, MW-25) on separate days.

##### **4.5.2 Analytical Methods**

The August and September 1994 soil and groundwater Phase II analytical results were evaluated to the accuracy, precision, completeness, and validity of the data. The analytical laboratory, ESG of Indianapolis, Indiana, utilized USEPA Method 8260, a purge and trap, gas chromatographic/mass spectrometric method for analysis of volatile organic compounds (VOC). Inorganic analysis was conducted using inductively coupled plasma atomic emission spectroscopy (USEPA Method 6010) for analysis of barium, copper, nickel, silver, and zinc; atomic absorption spectroscopy utilizing a graphite furnace technique for analysis of antimony (USEPA Method 7041), arsenic (USEPA Method 7060), beryllium (USEPA Method 7091), cadmium (USEPA Method 7131), chromium (USEPA Method 7191), lead (USEPA Method 7421), selenium (USEPA Method 7740), and thallium (USEPA Method 7841); and atomic absorption spectroscopy utilizing the cold-vapor technique for analysis of mercury (USEPA Method 7471).

##### **4.5.3 Data Validation Methods**

Methods used to evaluate the Phase II data were similar to the methods used to evaluate the Phase I data. Available sample collection documentation and laboratory quality control (QC) records were reviewed. Specifically, field notes and chain of custody documentation; the analytical methods used; sample holding times; initial and continuing instrument calibration data; and internal and external blank results were reviewed. Accuracy and precision of the data was evaluated by review of the surrogate (where appropriate), laboratory control sample (LCS), matrix spike (MS), and matrix spike duplicate (MSD) recoveries, as available; review of duplicate sample analyses; and comparison of this data to laboratory and USEPA established limits (USEPA 1986) and guidelines (USEPA 1988a and 1988b).

#### 4.5.4 Data Validation Results

##### General QC Considerations

Available QC information indicated that the samples were collected, preserved, and transported properly; appropriate analytical methods were utilized and the analyses were conducted within USEPA established holding times (USEPA, 1986). Mass Spectrometer tuning information and initial and continuing calibration data indicate that the analytical instruments were calibrated properly at the time of analysis. This data also documented that the analyses were conducted within the linear range of the instrumentation used.

##### Accuracy

With the exception of the six VOC analyses discussed below, surrogate (where appropriate), LCS, and MS recovery data indicated that all analyses met established laboratory or USEPA (USEPA, 1986) acceptance criteria for accuracy. Because of low recovery (indicative of poor analytical accuracy) of one of the VOC surrogate compounds (1,2-dichloroethane-d4), the results (Table 10) for groundwater samples 94-AMGW27-1, 94-AMGW4-1, 94-AMGW18-1, and 94-AMGW28-1, and trip blanks 94-AMTB16-1 and 94-AMTB17-1 were qualified as estimated (J or UJ data qualifier) for the following compounds: chloromethane, vinyl chloride, bromomethane, chloroethane, acetone, 1,1-dichloroethene, methylene chloride, carbon disulfide, trans-1,2-dichloroethene, 1,1-dichloroethane, 2-butanone, cis-1,2-dichloroethene, chloroform, 1,1,1-trichloroethane, and 1,2-dichloroethane.

##### Precision

Review of the results of matrix spike duplicate pairs indicate that the Phase II analyses are precise. All MS/MSD data were within USEPA or laboratory established limits.

##### Laboratory or Field Contamination

All method, trip, and equipment blank analytical results were reviewed for the presence of target compounds. The concentration of compounds detected in the blanks was compared to the concentration of these compounds detected in the associated environmental samples. Methylene chloride, a common lab artifact (USEPA 1988a), was detected in groundwater sample 94-AMGWR13-1 at a concentration less than 10 times the amount detected in the associated blanks; therefore, in accordance with USEPA guidance, the environmental sample result (Table 10) was flagged to indicate that the detection could be attributed to laboratory or field sampling contamination. For the Phase II VOC analyses, only this detection was attributed to contamination problems. No Phase II inorganic compound detections were attributed to laboratory or field sampling contamination.

**Completeness and Validity**

The completeness of the analytical data is defined as the percentage of the analytical results that are considered valid. USEPA guidelines (USEPA, 1988a and 1988b) indicate that data sets should be at least 80 percent complete. Based on the QC data reviewed, all data are valid and therefore the data sets are 100 percent complete.

## 5.0 CONCEPTUAL HYDROGEOLOGIC MODEL

Previous investigation reports for the Site established a baseline conceptual hydrogeologic model. This conceptual model included data generated by HDR, Terracon, and others. This section presents a review of this early Site conceptual model, presents HLA's present revised understanding of this model based on data collected during this RFI, and summarizes the impact this understanding has on plume transport and migration.

### Site Hydrogeology

Discussions in the Preliminary RCRA Facility Investigation Report, (Pre-RFI Report, HLA, 1991a), suggest that the subsurface geology consists of dense, gray, clay-rich glacial till interbedded with numerous and discontinuous sand units (HLA, 1991a, p. 19). The Pre-RFI Report discusses the "shallow aquifer" as consisting of near-surface sand units with groundwater occurring at 4 to 6 feet below surface. The report indicated that underlying the shallow sand unit is the dense, gray, silty clay; within which the sandy "intermediate aquifer" was described. It is the gray clay unit that inhibits transmission of water horizontally from a sand lens to adjacent sand lenses or vertically to the intermediate sand.

Previous reports indicate a horizontal groundwater flow direction to the southwest in the shallow aquifer and is to the south in the intermediate "aquifer" (HLA, 1991a).

Data collected as part of the present investigation has led to an updated interpretation of Site conditions. The presence of a near-surface sand unit separated from deeper sands by a nearly impermeable clayey till was confirmed through Site drilling and slug testing. Figures 5a through 6 illustrate the geometry of these sand layers. The shallow sand zone is more highly discontinuous than originally understood. Data from replacement monitoring wells installed during this investigation indicate that the deeper sands of the intermediate sand zone are much more discontinuous than originally understood; also, this is specifically demonstrated in the case of MW-R30, the deep replacement well for MW-30. The objective of this replacement monitoring well was to properly abandon the original well which was believed to be a conduit for cross contamination between the shallow and intermediate sands. The original MW-30 was also a poor monitoring point as it was screened in the clayey till below the relatively thick sand in the intermediate sand zone. MW-R30 was installed to provide a groundwater quality monitoring point in the intermediate sand zone. Sampling performed during installation of MW-R30, however, revealed the intermediate sand zone to be less than 5-feet thick. Furthermore, during drilling this sand lens behaved as a confined sand zone, with

the observed water level rising well into the drill casing. Subsequent to well installation and development, however, well yield was poor. This further suggests that the sand encountered in MW-R30 represents the stratigraphic pinch-out of the thick sand sequence observed in the original MW-30, 15 feet distant.

Review of Figure 6 reinforces the observed discontinuity of the sand layers in the intermediate sand zone toward the downgradient (southern) boundary of the Site, and cross gradient to the Site (east and west).

Figures 7 and 8 illustrate groundwater contours for the shallow water table and the piezometric surface measured in the intermediate sand zone, respectively. Horizontal groundwater flow in the shallow sand zone is to the southwest; horizontal groundwater flow in the intermediate sand zone is to the south. These observations are consistent with previous measurements of groundwater flow (HLA, 1991a, p. 20).

Horizontal groundwater flow velocity was calculated using hydraulic conductivity values obtained from slug test data. Although the approved DCQAP did not require that hydraulic conductivity tests be performed in monitoring wells screened in the clayey till, data was obtained from these wells as well as those wells screened in sand units. This data was grouped by well type, and an average hydraulic conductivity value was obtained for wells screened in predominantly sand and for wells screened predominantly in the clayey till. This is believed to be a more prudent approach compared to averaging all Site data, both sand and till wells combined because it is very likely that the preferred migration pathways are in the sand, as is discussed later at greater length.

Two values of hydraulic conductivity derived from the slug test data were therefore evaluated in calculating the average groundwater velocity at the Site. Using an average hydraulic conductivity ( $k$ ) of  $3.1 \times 10^{-3}$  cm/sec for wells screened in sand, and an average  $k$  of  $4.0 \times 10^{-5}$  cm/sec for wells screened in the clayey till, groundwater velocities were computed through the application of the Darcy equation:

$$v = ki/n,$$

where:  $k$  = average horizontal hydraulic conductivity  
 $i$  = hydraulic gradient  
 $n$  = porosity

Hydraulic gradient was evaluated from Figures 7 and 8 for each water-bearing unit by dividing the change in elevation by the horizontal distance between contour lines. As in previous estimates of porosity provided in the Pre-RFI report, it is assumed for these calculations that the average seepage porosity for all soil types is 30%. Given these conditions, groundwater velocity is estimated at 0.5 ft/d in the sand lenses, and 0.006 ft/d in the clay till. The actual site-wide groundwater velocity is somewhere between these values.

In addition to the estimate of the Darcy groundwater velocity, an understanding of flow conditions at the Site can be appreciated by comparing concentrations of organic constituents in groundwater detected in past sampling rounds compared to recent groundwater sampling performed as part of this RFI. Figure 9 is adapted from the Pre-RFI and illustrates concentrations of organic constituents in the groundwater monitoring well network from the date of the sampling event, January-February 1990. Summing total organic concentrations reveals that MW-13 contained the single highest total organic concentration of all monitoring wells at that time. PCE was particularly elevated in this well. Comparing these results with the data collected in Sept-Oct 1994 (Figures 10 and 11) reveals that MW-11, which is nearly directly downgradient from MW-13, has the highest total concentration of organic constituents, in particular PCE. This apparent shift of the center of mass of the plume from the location of MW-13 to the location of MW-11 is consistent with interpretations of groundwater flow based on piezometric data calculated above, assuming that the migration of impacted groundwater across the Site is influenced by the range of hydraulic conductivity values described above.

Drawing all previously presented interpretations together, a comparison can be made between Figure 6, Geologic Fence Diagram, and Figure 11, Total VOC concentration map, groundwater. The occurrence of organic constituents in groundwater corresponds to those monitoring wells where sandy soils were encountered. Conversely, monitoring wells containing little or no sand, i.e., predominantly clayey till, are virtually absent of organic constituents. Specific examples are dramatically revealed in comparing these two diagrams. For example, MW-11, MW-R13, and MW-R17 contain either thick sand seams or surficial unconsolidated fill materials. As indicated by Figure 10, the Groundwater Total VOC Isoconcentration Contour Map, these wells had significant concentrations of total organic constituents in groundwater. Monitoring well locations MW-32, MW-16, MW-15, MW-18, and MW-28 depicted on Figure 6, and MW-12 depicted on Figure 5b, were either void of sand or were on the marginal fringe of sand stringers. Groundwater samples analyzed from these locations reveal organic concentrations less than the method detection limit.



Migration pathways at the Site are controlled by hydraulic gradient and the occurrence and orientation of sands in the glacial till. The thinning of the groundwater plume to the south as depicted on Figure 10 is a direct result of the pinching of sands in this direction, as evident on Figure 5a. Sands occurring south of the plume, such as that in MW-22, are not likely in hydraulic communication with the sands containing organic constituents north of this location. Similarly, the western limit of the organic plume is controlled by the pinchout of sands observed in MW-30. MW-32 located due west of MW-30, contained clay.

Groundwater migration pathways at the Site are therefore controlled by hydraulic gradient and the occurrence and orientation of sands in the glacial till. The horizontal extent of the plume is delineated based on the abundance of subsurface explorations performed at the Site. Explorations performed in the intermediate sand zone reveal that these sands (e.g. MW-R30) are of very limited horizontal and vertical extent. Low detections of organic constituents observed in these wells can be attributed to cross-contamination associated with past Site investigations.

## 6.0 EXPOSURE ASSESSMENT

### 6.1 Introduction and Approach

This section presents a human health exposure assessment for the Site. The exposure assessment process is a critical first step in evaluating risks posed by chemicals released to the environment at the Site. This exposure assessment follows the methodology and approaches recommended by USEPA in *Risk Assessment Guidance for Superfund* (USEPA, 1989a) and the *RCRA Facility Investigation (RFI) Guidance* (USEPA, 1989b). This exposure assessment includes the following components:

- A conceptual site model for the Site (Section 6.2)
- Characterization of the exposure setting (Section 6.3)
- Evaluation of potentially exposed populations and exposure pathways (Section 6.4)
- Summary and conclusions (Section 6.5).

In a typical exposure assessment, exposure would be quantified following identification of complete exposure pathways. However at this Site, no complete current exposure pathways required quantification. Therefore, quantification was not performed for this exposure assessment. Based upon the definition that a risk cannot exist without a complete pathway, incomplete or interrupted exposure pathways are not quantified.

### 6.2 Conceptual Site Model for the Site

A conceptual site model (CSM) includes general information on waste sources, pathways, and receptors at a site and is an essential tool for understanding and evaluating how people may be exposed to chemicals at a site. The CSM for this Site, presented in Figure 12 and described below, includes reasonable, potential pathways and receptors for the Site. These potential pathways and receptors are then evaluated in greater detail in Sections 6.3 and 6.4.

#### 6.2.1 Source of Chemicals at the Site

For purposes of this exposure assessment, the chemical source at the Site is defined as the volatile organic compounds that have been detected in the shallow groundwater underneath the Site. The areas of contamination are localized primarily to sandy lenses occurring within 25 feet of the ground surface. Connections between these lenses are discontinuous, although sufficient connection exists to allow some limited horizontal chemical migration in the shallow groundwater across the Site. A more complete discussion of the chemicals detected in the shallow groundwater is presented in Section 4.3.

### 6.2.2 Potential Chemical Migration Pathways

The source area was evaluated for potential releases to other media, including air, soil, surface water and sediments. Based on this evaluation, the following potential pathways have been included in the CSM (Figure 12), and are evaluated for completeness in Section 6.4:

1. VOCs in groundwater to surface water
2. VOCs in groundwater to potable groundwater wells
3. VOCs in groundwater to deeper aquifers
4. VOCs in groundwater to air.

### 6.2.3 Potentially Exposed Populations

Populations that could potentially be exposed to VOCs in groundwater at the Site via the pathways described above include onsite and offsite receptors. Both onsite and offsite receptors were included in current and future exposure scenarios (Figure 12).

Potential current and future receptors include workers and visitors. There are no potential current offsite receptors considered. Potential future offsite receptors were considered as a single group, and not specifically defined.

## 6.3 Characterization of the Exposure Setting at the Site

This section summarizes the relevant characteristics of the physical and environmental setting of the Site. Important physical, hydrogeological, and demographic characteristics of the Site and surrounding areas are also described.

### 6.3.1 Characterization of the Physical Setting

This section presents basic Site characteristics, including the Site location, local land use and zoning patterns, and regional water supply. Additional Site characterization details were presented in Section 2.0 of this report.

#### Local Land Use

The Site is located in an area that is currently zoned for general commercial use (Figure 2, HLA, 1991a). There are no known plans to change zoning regulations in the Site vicinity. Directly west of the Site is 3M Corporation, which is zoned for current and future general industrial use. At the southwest corner of the Ames Site is property owned by JT&S Development. Story Construction

Company is located along the remaining southern border of the Site. According to the City of Ames, 1988 Land Use Policy Plan, current land use surrounding the Site is categorized as follows. Land within at least 1/2 mile west and south of the site, is categorized as "Industrial Use," intended for "General Industrial Use." Land within at least 1/2 mile north of the Site, is categorized as "Industrial Service," intended for "High Tech, Research, and Planned Industrial Facilities." Land within at least 1/2 mile east of the Site, is categorized as "Industrial Reserve," intended for "Future Industrial Expansion." No residences are within a half-mile to the east, west, or south of the Site (HLA, 1991a). Conversations with Sauer-Sundstrand personnel indicate that the facility is expanding its operations and will continue to operate in the foreseeable future.

#### **Facility and Regional Water Supply**

No city water supply wells were identified within one mile of the Site (HLA, 1991a). Eight residential wells are located within a three-mile radius. The nearest known well to the Site is approximately 4,400 feet southeast of the Site and is set in glacial till at a depth of 140 feet (HLA, 1991a). All the public water supply and residential wells identified in the region are screened at depths greater than 100 feet deep. No local wells were identified that used the shallow groundwater.

#### **6.3.2 Characterization of the Environmental Setting**

This section presents the environmental setting of the Site, including local and regional geology and hydrogeology, climate and meteorology, and the presence and location of surface water bodies. A more complete discussion of Site geology and hydrology is presented in previous sections of this report.

##### **Site Geology**

The topsoil at the Site is underlain by a brown fill material that is less than five feet thick. The fill material merges into a tan silty, sandy clay, containing thin and discontinuous sand units. At a depth of approximately 15 feet, the tan clay grades into a hard, silty clay. The depth to bedrock is approximately 120 feet. The surface topography generally dictates the direction of surface water runoff and near surface drainage. The direction of surface water runoff at the Site is to the southwest. An additional discussion of the Site geology is presented in Section 2.1.

##### **Site Hydrogeology**

A detailed analysis of the Site hydrogeologic conceptual model is provided in the previous section. In summary, previously identified "shallow" and "intermediate" sands consist of vertically and horizontally discontinuous sand layers within the dense, low-permeability glacial till. Intermediate

sands are substantially more discontinuous than previously understood from earlier studies. Natural hydraulic migration conduits from the intermediate to shallow sands are virtually nonexistent (Figures 5a, 5b and 6). Rates of water yield from monitoring wells in the shallow sand zone were highly variable, as a direct result of the variations in soil type.

The groundwater investigation performed for the RFI did not identify any significant natural or artificial point of contact between the shallow and intermediate sands below the Site, between the shallow and intermediate sands below the Site and the regional aquifers, or between the sands below the Site and surface water bodies (Figures 5a, 5b and 6). The potential for horizontal migration of the intermediate groundwater toward the downgradient Site boundary was also evaluated as part of this RFI. The results indicated that the groundwater flow was interrupted by pinched-off, discontinuous sand layers that do not likely provide a continuous transport pathway to offsite areas. Vertical transfer from the shallow sand zones to intermediate sand zones is limited by the discontinuity of the shallow sand pockets and the impermeability of the gray clay between the shallow and intermediate sand zones.

#### **Surface Water**

No naturally-occurring surface water bodies (lakes, streams, or creeks) are present onsite. The south branch of the Skunk River is located approximately three-quarters of a mile west of the Site and flows north-to-south (Figure 1). No complete migration pathway between the shallow groundwater and Skunk River has been identified.

#### **Site Impacts on Local Hydrology**

The two primary impacts on Site hydrology include a drainage ditch and a flood control basin (Figure 3). The drainage ditch transports water from locations northeast of the Site in a southwest direction to the flood control basin onsite. The flood control basin is triangularly shaped and covers approximately 20,000 square feet. Neither the drainage ditch nor the flood control basin directly intercepts any surface water bodies. Therefore, precipitation that follows the drainage ditch to the basin is evaporated or recharged into the soils.

### **6.4 Evaluation of Potentially Exposed Populations and Exposure Pathways**

This section presents an evaluation of potentially exposed populations and exposure pathways that were identified in the CSM.

#### 6.4.1 Current Populations

Populations who may currently be present onsite include onsite workers and visitors or trespassers. The property is completely fenced, with gate access. The fence and lack of pedestrian walkways will reduce the likelihood of trespassers at the Site.

Local offsite populations are limited primarily to commercial and industrial workers, since the Site is located in an industrial area. No residential populations exist adjacent to the Site. Limited residential populations that are located one-half mile northwest of the Site do not have any direct contact with the Site.

The Site does not rely upon groundwater supplies from on- or offsite groundwater reserves within at least a one-mile radius. The Site, along with the other local offsite businesses and the surrounding regional population, rely upon city wells that are remote from the Site and are screened at depths greater than 100 feet.

#### 6.4.2 Future Populations

Future land use is expected to remain the same as current land use, according to the *City of Ames 1988 Land Use Policy Plan*, the most recent plan available at this writing. No significant changes in land use of the Site are anticipated. The area surrounding the site is ideal for continued and future industrial development, due to the adjacent interstate and railroad (personal communication, Anne Packard, City of Ames, Planning Department). According to the land use Policy Plan, "Commercial activity will be encouraged to develop adjacent to major interchanges where traffic arterials will allow for safe ingress and egress." The city's Land Use Policy Plan indicates that the nearest existing and future residential zoning is one mile west of the site. Overall, there is low potential for residential growth in the immediate vicinity of the Site. The projected future populations of the City of Ames anticipate very slight growth (1990: 47,198 residents; 1995: 48,550 residents; 2000: 49,900 residents). Future recreational usage in the vicinity is limited by industrial zoning, as well as the lack of any attractive recreational features such as lakes or streams.

The feasibility of future development of the shallow groundwater at the Site is very low. A survey of wells outside of the area establishes that current wells are screened at depths below the shallow sand zone (HLA, 1991a). Hydrogeological investigations of the Site have shown poor yields from the shallow groundwater, due to low hydraulic transmissivities and the discontinuous, isolated nature of the shallow sand pockets that make up the shallow sand zone.

### **6.4.3 Identification of Potential Exposure Pathways**

#### **Current Exposure Pathways**

As previously described, the shallow groundwater at the Site and in the local vicinity is not currently used. Hence, there are no direct exposures to Site personnel or to Site visitors via the potable well pathway.

As discussed in Section 6.3.2, there is no complete pathway between Site groundwater and surface water and, therefore, this pathway is no longer considered. As also discussed in Section 6.3.2, there is no complete pathway between VOCs in groundwater at the Site and potential deeper sand zones, if they exist; therefore, this pathway is no longer considered.

The only potentially complete current exposure pathway is inhalation of volatiles that have migrated into the ambient air. However, any exposure of Site personnel by this pathway would be very small, due to the limited amount of time a worker would be located directly above the impacted areas of shallow groundwater, the vegetation covering the Site, and lack of buildings above the VOC plume. In addition, any chemical that was released from the groundwater into the ambient air would undergo tremendous dispersion in the air before reaching a worker's breathing zone. Any potential exposures via the inhalation of ambient air pathway would be negligible. Because no buildings are located over the shallow groundwater zones at the Site, chemicals are not likely to migrate into indoor air. This ambient air analysis indicates no current exposures of significance, either indoors or outdoors, to the shallow groundwater at the Site.

#### **Future Exposure Pathways**

Future exposure pathways are treated the same as current exposure pathways to surface water and deeper aquifers, in that both current and future pathways are incomplete and, therefore, not considered further. Future exposure via the air pathway is unlikely for the same reasons described above for current exposures.

Future exposure to VOCs in groundwater via potable wells is unlikely because of the unlikely probability that potable wells will be drilled onsite or offsite, downgradient of the present plume. The unlikely probability of potable wells in the shallow groundwater in the Site vicinity is due to poor well yields, discontinuous and isolated nature of the shallow sand pockets, and the industrialized nature of the area as discussed in previous sections.

## 6.5 Summary and Conclusions

This section summarizes the results of the exposure assessment for shallow groundwater at the Site.

The chemical source of interest for this assessment was VOCs detected in the shallow groundwater in the southeastern portion of the Site. Potential migration pathways that were evaluated included transport to surface water, potable wells, deeper aquifers, and air. A number of potential migration pathways were found to be incomplete by means of physical barriers or isolation of the media of concern. Current human populations evaluated included onsite workers and Site visitors or trespassers. Future populations that were considered include onsite workers, onsite visitors or trespassers, and offsite receptors. Three groundwater exposure pathways, including ingestion, dermal contact, and inhalation, were considered in this exposure assessment.

The only potentially complete pathway identified under either current or future Site use was inhalation of VOCs emitted from the shallow groundwater into the ambient air. However, any potential exposure resulting from this pathway is extremely low, and very unlikely to pose a significant risk to onsite personnel.

In summary, based on this exposure analysis, it is concluded that exposures to VOCs in shallow groundwater in the southeastern portion of the Site are either nonexistent, highly unlikely, or are of minimal significance. Thus, the human health risks posed by the VOCs detected in the shallow groundwater are extremely low.



## 7.0 SUMMARY AND CONCLUSIONS

The following summarizes findings and interpretations of data from the RFI:

- Geologic data obtained through soil borings indicates that the subsurface geology consists of clayey glacial till with horizontally and vertically discontinuous sand lenses. These sand lenses were previously identified by others as the "shallow" and "intermediate" sand zones.
- The shallow and intermediate water bearing zones are not likely to be hydraulically connected.
- Chemical analysis of soil and groundwater samples indicate that metals are not impacting soil or groundwater. Shallow groundwater has been impacted with volatile organic compounds (VOC). Low concentrations of VOCs were detected in the intermediate water bearing zone and may be residual contamination likely resulted from poorly constructed monitoring wells which have been properly abandoned, thereby eliminating this pathway and source to the intermediate zone.
- Geologic diagrams reveal that the shallow groundwater plume coincides with the horizontal distribution of the sand lenses - the plume is apparently not present where these sands are not present or are very thin.
- The results of the exposure assessment indicate that there is likely only one potentially complete exposure pathway at the Site: volatilization of VOCs from groundwater to air. Health risks associated with this pathway are negligible.

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## **TABLES**

**Table 1. Soil Total Metals Data Summary**  
**Sauer-Sundstrand Facility**  
**Ames, Iowa**

Sample Date	Sample ID	Sample Description	Interval (ft)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
<b>Background</b>											
9-9-93	BACK 101	93-AMSS1-1	7.0-7.5	2.980	98.400	<1.00	8.700	4.7000	<0.100	<2.50	<2.00
9-9-93	BACK 101	93-AMSS2-1	11.0-11.5	<2.00	69.300	<1.00	9.300	4.0000	<0.100	<2.50	<2.00
9-9-93	BACK 102	93-AMSS3-1	5.0-5.5	<2.00	57.100	<1.00	8.500	4.0000	<0.100	<2.50	<2.00
9-9-93	BACK 102	93-AMSS3-1	5.0-5.5	<2.00	57.100	<1.00	8.500	4.0000	<0.100	<2.50	<2.00
9-9-93	BACK 102	93-AMSS4-1	13.0-13.5	<2.00	91.200	<1.00	11.700	4.4800	<0.100	<2.50	<2.00
<b>SWMU4a</b>											
9-27-93	SWMU 4A-101	93-AMSS11-1	6.0-8.0	<2.00	<40.0	<1.00	2.500	1.0900	<0.100	<2.50	<2.00
9-27-93	SWMU 4A-101	93-AMSS12-1	12.0-16.0	<2.00	68.500	<1.00	9.500	4.6300	<0.100	<2.50	<2.00
9-27-93	SWMU 4A-101	93-AMSSDUP12-1	12.0-16.0	<2.00	70.900	<1.00	7.900	4.2800	<0.100	<2.50	<2.00
9-27-93	SWMU 4A-102	93-AMSS13-1	6.0-8.0	<2.00	<40.0	<1.00	3.200	0.6470	<0.100	<2.50	<2.00
9-27-93	SWMU 4A-102	93-AMSS14-1	10.0-12.0	<2.00	<40.0	<1.00	5.800	0.8790	<0.100	<2.50	<2.00
9-24-93	SWMU 4A-103	93-AMSS15-1	5.0-6.0	2.070	<40.0	<1.00	2.900	1.7600	<0.100	<2.50	<2.00
9-24-93	SWMU 4A-103	93-AMSS16-1	13.0-16.0	<2.00	76.800	<1.00	8.500	4.9100	<0.100	<2.50	<2.00
9-24-93	SWMU 4A-103	93-AMSSDUP16-1	13.0-16.0	3.010	84.000	<1.00	10.700	5.1000	<0.100	<2.50	<2.00
9-24-93	SWMU 4A-104	93-AMSS21-1	5.0-6.0	<2.00	<40.0	<1.00	3.000	0.9260	<0.100	<2.50	<2.00
9-24-93	SWMU 4A-104	93-AMSS23-1	11.0-11.5	2.480	75.200	<1.00	9.600	4.2600	<0.100	<2.50	<2.00
<b>U.S. EPA Performance Samples</b>											
9-15-93	MW-R	93-AMSS141-1	N/A	2.880	50.100	<1.00	3.600	10.5000	<0.100	<2.50	<2.00
9-15-93	MW-R	93-AMSS142-1	N/A	2.980	49.100	95.300	3.600	6.2000	1.0000	<2.50	<2.00
<b>Monitoring Well Replacement Soil Samples</b>											
9-15-93	MW-R2S	93-AMSS101-1	4.0-6.0	2.760	55.600	<1.00	8.900	4.4800	<0.100	<2.50	<2.00
9-15-93	MW-R2S	93-AMSSDUP101-1	4.0-6.0	<2.00	51.000	<1.00	8.700	3.5000	<0.100	<2.50	<2.00
9-15-93	MW-R2S	93-AMSS102-1	7.0-8.0	<2.00	76.000	<1.00	9.000	4.5200	<0.100	<2.50	<2.00
<b>U.S. Geological Survey Published Average</b>											
NA	NA	NA	0.7	7.00	670	NE	56	2.0	0.065	0.34	NE

**Notes:**

Units for RFI samples are milligrams per kilogram (mg/kg) - equivalent to parts per million

Units for U.S. Geological Survey Published Average are micrograms per gram (ug/g) - equivalent to parts per million

< not detected at quantification limit shown

N/A not applicable

NE none established

**Table 2. Soil VOC Data Summary**  
 Sauer-Sundstrand Facility  
 Ames, Iowa

Sample Date	Sample ID	Sample Description	Interval (ft)	Trichloro fluoromethane	Acrolein	Acetone	1,1-DCE	Methylene Chloride	Carbon Disulfide	1,1-DCA	2-Butanone	C-1,2-DCE	Chloroform	1,1,1-TCA	TCB	2-Hexanone	Toluene	PCH	Ethylbenzene	Total Xylenes
<b>SWMU3</b>																				
29-Sep-93	SWMU3-101	93-AMSS131-1	4.0-6.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
29-Sep-93	SWMU3-101	93-AMSS132-1	8.0-10.0	<10	<25	BQL	<5.0	BQLB	<5.0	BQL	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
29-Sep-93	SWMU3-101	93-AMSSDUP132-1	8.0-10.0	<10	<25	BQL	<5.0	BQLB	<5.0	BQL	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	BQL	<5.0	<5.0
<b>SWMU4a</b>																				
27-Sep-93	SWMU4A-101	93-AMSS11-1	6.0-8.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
27-Sep-93	SWMU4A-101	93-AMSS12-1	12.0-16.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	7.2B	BQL	<5.0	<5.0
27-Sep-93	SWMU4A-101	93-AMSSDUP12-1	12.0-16.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0
27-Sep-93	SWMU4A-102	93-AMSS13-1	6.0-8.0	<10	<25	BQL	<5.0	BQLB	BQL	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0
27-Sep-93	SWMU4A-102	93-AMSS14-1	10.0-12.0	<10	<25	BQL	<5.0	BQLB	BQL	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0
24-Sep-93	SWMU4A-103	93-AMSS15-1	5.0-6.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	BQL	BQL	<5.0	<5.0	<5.0
24-Sep-93	SWMU4A-103	93-AMSS16-1	13.0-16.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
24-Sep-93	SWMU4A-103	93-AMSSDUP16-1	13.0-16.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
24-Sep-93	SWMU4A-104	93-AMSS21-1	5.0-6.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	BQL	<5.0	<5.0
24-Sep-93	SWMU4A-104	93-AMSS22-1	9.5-10.0	<10	<25	BQL	<5.0	BQLB	5.3	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
<b>SWMU6</b>																				
14-Sep-93	SWMU6-102	93-AMSS121-1	2.5-3.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
14-Sep-93	SWMU6-102	93-AMSS122-1	4.5-5.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	<5.0	6.6	<5.0	<5.0	9.7	<5.0	BQL	BQL	<5.0	<5.0
14-Sep-93	SWMU6-101	93-AMSS123-1	2.5-3.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
14-Sep-93	SWMU6-101	93-AMSS124-1	7.0-8.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
14-Sep-93	SWMU6-101	93-AMSS124DUP-1	7.0-8.0	<10	<25	BQL	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
<b>SWMU15</b>																				
28-Sep-93	SWMU15-101	93-AMSS31-1	2.0-4.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
28-Sep-93	SWMU15-101	93-AMSS32-1	14.0-16.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQLB	<5.0	<5.0
28-Sep-93	SWMU15-101	93-AMSSDUP32-1	14.0-16.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
28-Sep-93	SWMU15-102	93-AMSS33-1	6.0-8.0	<10	<25	BQLB	<5.0	5.7B	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
28-Sep-93	SWMU15-102	93-AMSS34-1	14.0-16.0	<10	<25	<25	<5.0	BQLB	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Table 2. Soil VOC Data Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Interval (ft)	Trichloro fluoromethane	Acrolein	Acetone	1,1-DCE	Methylene Chloride	Carbon Disulfide	1,1-DCA	2-Butanone	C-1,2-DCE	Chloroform	1,1,1-TCA	TCB	2-Hexanon	Toluene	PCE	Ethylbenzene	Total Xylenes
South Soil Borings																				
09-Sep-93	SOUTH 101	93-AMSS41-1	7.0-7.5	<10	<25	BQL B	<5.0	7.0 B	<5.0	<5.0	BQL B	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
09-Sep-93	SOUTH 101	93-AMSSDUP41-1	7.0-7.5	<10	<25	<25	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
09-Sep-93	SOUTH 101	93-AMSS42-1	14.5-15.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
10-Sep-93	SOUTH 102	93-AMSS43-1	19.5-20.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
10-Sep-93	SOUTH 102	93-AMSSDUP43-1	19.5-20.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	BQL B
10-Sep-93	SOUTH 102	93-AMSS44-1	9.5-10.0	<10	<25	<25	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
10-Sep-93	SOUTH 103	93-AMSS45-1	13.5-14.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0
10-Sep-93	SOUTH 103	93-AMSS47-1	21.5-22.0	<10	<25	BQL B	<5.0	6.3 B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0
13-Sep-93	SOUTH 104	93-AMSS46-1	22.7-23.2	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
13-Sep-93	SOUTH 104	93-AMSS47-1	7.0-7.5	<10	<25	<25	<5.0	5.4 B	<5.0	<5.0	<10	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
13-Sep-93	SOUTH 104	93-AMSSDUP47-1	7.0-7.5	<10	<25	<25	<5.0	6.0 B	<5.0	<5.0	<10	<5.0	BQL	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	BQL
11-Sep-93	SOUTH 105	93-AMSS49-1	6.5-7.0	<10	<25	<25	<5.0	5.3 B	<5.0	<5.0	<10	<5.0	BQL	10	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
11-Sep-93	SOUTH 105	93-AMSS50-1	20.0-20.5	<10	<25	BQL B	<5.0	6.1 B	<5.0	<5.0	<10	<5.0	BQL	BQL	<5.0	<5.0	<5.0	BQL	BQL	BQL
11-Sep-93	SOUTH 106	93-AMSS51-1	13.5-14.0	<10	<25	BQL B	BQL	10 B	<5.0	<5.0	BQL	<5.0	BQL	7.2	<5.0	<5.0	BQL	BQL	BQL	BQL
11-Sep-93	SOUTH 106	93-AMSS52-1	20.5-21.0	<10	<25	BQL B	<5.0	5.0 B	<5.0	BQL	BQL B	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
11-Sep-93	SOUTH 106	93-AMSSDUP52-1	20.5-21.0	<10	<25	BQL B	<5.0	5.3 B	<5.0	BQL	BQL B	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
17-Sep-93	SOUTH 107	93-AMSS53-1	5.0-6.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
17-Sep-93	SOUTH 107	93-AMSS54-1	17.5-18.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
17-Sep-93	SOUTH 107	93-AMSSDUP54-1	17.5-18.0	<10	<25	BQL B	<5.0	5.8 B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 108	93-AMSS55-1	9.0-10.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 108	93-AMSSDUP55-1	9.0-10.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 108	93-AMSS56-1	15.0-16.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 109	93-AMSS57-1	18.0-18.5	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 109	93-AMSS58-1	24.0-25.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 110	93-AMSS59-1	16.5-17.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	BQL	7.3
21-Sep-93	SOUTH 110	93-AMSS60-1	29.0-30.0	<10	<25	BQL	<5.0	BQL B	BQL	<5.0	BQL B	<5.0	<5.0	12	<5.0	<5.0	BQL	<5.0	BQL	14
16-Sep-93	SOUTH 111	93-AMSS61-1	3.0-4.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
16-Sep-93	SOUTH 111	93-AMSS62-1	17.0-18.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
16-Sep-93	SOUTH 111	93-AMSSDUP62-1	17.0-18.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL
16-Sep-93	SOUTH 112	93-AMSS63-1	19.0-20.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
16-Sep-93	SOUTH 112	93-AMSS64-1	14.0-15.0	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
16-Sep-93	SOUTH 113	93-AMSS65-1	0.5-1.0	BQL	<25	BQL	<5.0	6.8 B	<5.0	<5.0	<10	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	BQL B	BQL	BQL
16-Sep-93	SOUTH 113	93-AMSS66-1	14.0-14.5	<10	BQL	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	BQL
21-Sep-93	SOUTH 114	93-AMSS67-1	12.5-13.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	SOUTH 114	93-AMSS68-1	23.5-24.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	BQL	BQL	BQL
Replacement Wells																				
15-Sep-93	MW-R2S	93-AMSS101-1	4.0-6.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
15-Sep-93	MW-R2S	93-AMSSDUP101-1	4.0-6.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	BQL	BQL	5.9
15-Sep-93	MW-R2S	93-AMSS102-1	7.0-8.0	<10	<25	BQL	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
25-Aug-94	MW-R30	94-AMSS104-1	6.0-7.0	NA	NA	<25	<5.0	<5.0	<5.0	<5.0	<10	<5.0	<5.0	26	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
25-Aug-94	MW-R30	94-AMSS105-1	11.0-11.5	NA	NA	<25	<5.0	<5.0	<5.0	<5.0	<10	8.4	<5.0	50	<5.0	<5.0	<5.0	BQL	<5.0	<5.0
25-Aug-94	MW-R30	94-AMSSDUP105-1	6.0-7.0	NA	NA	<25	<5.0	<5.0	<5.0	<5.0	<10	<5.0	<5.0	17	<5.0	<5.0	<5.0	BQL	<5.0	<5.0

Notes:  
All units are micrograms per kilogram (ug/kg)  
< not detected above quantification limit shown  
BQL detected below quantification limit  
B compound detection attributed to laboratory or field sampling contamination; compound detected in the environmental sample at a concentration less than 10 times (for acetone, methylene chloride, 2-butanone and toluene) or 5 times (all other target compounds) the amount detected in the associated internal or external blanks.  
J estimated value  
UJ estimated quantification limit  
NA not analyzed  
Samples analyzed for full range of Method 8246 analytes. Only those compounds above detection limit in one or more sample are reported.

Table 3. Soil pH Data Summary  
 Sauer-Sundstrand Facility  
 Ames, Iowa

Date Sampled	Sample ID	Sample Description	Interval	Standard 10% pH Value Test
9/27/93	SWMU 4A-101	93-AMSS 11-1	6.0' - 8.0'	8.72
9/27/93	SWMU 4A-101	93-AMSS 12-1	12.0' - 16.0'	9.51
9/27/93	SWMU 4A-101	93-AMSS DUP 12-1	12.0' - 16.0'	9.50
9/27/93	SWMU 4A-102	93-AMSS 13-1	6.0' - 8.0'	9.14
9/27/93	SWMU 4A-102	93-AMSS 14-1	10.0' - 12.0'	9.35
9/27/93	SWMU 4A-101	93-AMSS 24-1	2.0' - 4.0'	9.02
9/27/93	SWMU 4A-102	93-AMSS 25-1	2.0' - 4.0'	8.96



**Table 4. PHASE I - VOC QA/QC Data Summary**  
**Sauer-Sundstrand Facility**  
**Ames, Iowa**

Sample Date	Sample ID	Sample Description	Trichloro fluoromethane	Acetone	Methylene Chloride	2-Butanone	Chloroform	1,1,1-Trichloro ethane	Toluene	Tetrachloro ethene	Ethylbenzene	Total Xylenes	Styrene
09-Sep-93	Equipment Blank	93-AMEB1-1	<10	BQL	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
10-Sep-93	Equipment Blank	93-AMEB2-1	<10	BQL	BQL	<10	<5.0	<5.0	<5.0	<5.0	<5.0	BQL	<5.0
11-Sep-93	Equipment Blank	93-AMEB3-1	<10	BQL	BQL	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
13-Sep-93	Equipment Blank	93-AMEB4-1	<10	BQL	BQL B	<10	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0
14-Sep-93	Equipment Blank	93-AMEB5-1	<10	<25	BQL B	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
15-Sep-93	Equipment Blank	93-AMEB6-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
16-Sep-93	Equipment Blank	93-AMEB7-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
17-Sep-93	Equipment Blank	93-AMEB8-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	Equipment Blank	93-AMEB9-1	<10	BQL	BQL	BQL B	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
21-Sep-93	Equipment Blank	93-AMEB9A-1	<10	<25	BQL	BQL B	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
24-Sep-93	Equipment Blank	93-AMEB10-1	<10	BQL B	BQL	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
27-Sep-93	Equipment Blank	93-AMEB11-1	14	BQL B	<5.0	BQL B	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0
28-Sep-93	Equipment Blank	93-AMEB12-1	<10	<25	BQL B	BQL B	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0
29-Sep-93	Equipment Blank	93-AMEB13-1	<10	<25	BQL B	BQL B	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
09-Sep-93	Trip Blank	93-AMTB1-1	<10	BQL	BQL	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
10-Sep-93	Trip Blank	93-AMTB2-1	<10	BQL	BQL	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
11-Sep-93	Trip Blank	93-AMTB3-1	<10	BQL	6.9	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
14-Sep-93	Trip Blank	93-AMTB4-1	<10	BQL B	BQL B	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
15-Sep-93	Trip Blank	93-AMTB5-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
17-Sep-93	Trip Blank	93-AMTB6-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	Trip Blank	93-AMTB7-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
24-Sep-93	Trip Blank	93-AMTB8-1	<10	BQL B	BQL	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
27-Sep-93	Trip Blank	93-AMTB9	<10	BQL B	<5.0	BQL B	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
28-Sep-93	Trip Blank	93-AMTB10-1	<10	<25	BQL B	BQL B	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
29-Sep-93	Trip Blank	93-AMTB11-1	<10	<25	BQL B	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	BQL
09-Sep-93	Source Water	93-AMSOU1-1	<10	BQL	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
15-Sep-93	Source Water	93-AMSOU2-1	<10	<25	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	Source Water	93-AMSOU3-1	<10	BQL B	<5.0	BQL B	BQL	<5.0	BQL	<5.0	BQL	14	BQL

Notes:

All units are micrograms per liter (ug/L)

< not detected above quantification limit shown

BQL detected below quantification limit

J estimated value

UJ estimated quantification limit

N/A not applicable

Samples analyzed for full range of Method 8260 analytes.

Only those compounds above detection limit in one or more samples are reported.

**Table 5. Sediment VOC Data Summary**  
**Sauer-Sundstrand Facility**  
**Ames, Iowa**

Sample Date	Sample ID	Sample Description	Chloro-methane	Trichloro fluoromethane	Acrolein	Acetone	1,1-DCE	Methylene Chloride	Carbon Disulfide	1,1-DCA	2-Butanone	1,2-Dichloro benzene
20-Sep-93	SED-01	93-AMSD91-1	<10	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0
20-Sep-93	SED-03	93-AMSD93-1	<10	<10	<25	BQL B	<5.0	5.5 B	<5.0	<5.0	BQL B	<5.0
20-Sep-93	SED-04	93-AMSD94-1	<10	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0
20-Sep-93	SED-05	93-AMSD95-1	BQL B	<10 UJ	<25 UJ	BQL B	<5.0 UJ	14 B	<5.0 UJ	6.9 J	BQL B	<5.0 UJ
20-Sep-93	SED-06	93-AMSD96-1	<10	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0
20-Sep-93	SED-07	93-AMSD97-1	BQL B	<10 UJ	<25 UJ	28 B	<5.0 UJ	BQL B	BQL J	<5.0 UJ	11 B	<5.0 UJ
20-Sep-93	DUP-SED-07	93-AMSDDUP97-1	12 B	<10 UJ	<25 UJ	BQL B	<5.0 UJ	BQL B	<5.0 UJ	<5.0 UJ	BQL B	<5.0 UJ
20-Sep-93	SED-08	93-AMSD98-1	<10	<10	<25	BQL B	<5.0	BQL B	<5.0	<5.0	BQL B	<5.0

Sample Date	Sample ID	Sample Description	cis-1,2-DCE	Chloroform	1,1,1-TCA	TCE	2-Hexanone	Toluene	4-Methyl 2-pentanone	PCE	Ethylbenzene	Total Xylenes	Styrene
20-Sep-93	SED-01	93-AMSD91-1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	SED-03	93-AMSD93-1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	SED-04	93-AMSD94-1	<5.0	<5.0	<5.0	BQL	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	SED-05	93-AMSD95-1	6.8 J	<5.0 UJ	<5.0 UJ	BQL J	BQL J	<5.0 UJ	BQL J	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ
20-Sep-93	SED-06	93-AMSD96-1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
20-Sep-93	SED-07	93-AMSD97-1	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	8.7 B	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ
20-Sep-93	DUP-SED-07	93-AMSDDUP97-1	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	BQL B	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ	<5.0 UJ
20-Sep-93	SED-08	93-AMSD98-1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Notes:

All units are micrograms per kilogram (ug/kg)

< not detected above quantification limit shown

BQL detected below quantification limit

B compound detection attributed to laboratory or field sampling contamination; compound detected in the environmental sample at a concentration less than 10 times (for acetone, methylene chloride, 2-butanone and toluene) or 5 times (all other target compounds) the amount detected in the associated internal or external blanks.

J estimated value

UJ estimated quantification limit

Samples analyzed for full range of Method 8260 analytes.

Only those compounds above detection limits in one or more samples are reported.

Table 6. Sediment Metals Data Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Antimony	Beryllium	Copper	Nickel	Thallium	Zinc
9-20-93	SED-01	93-AMSD91-1	<2.00	72.200	<1.00	12.600	6.4500	<0.100	<2.50	<2.00	<12.00	<1.00	9.200	<8.00	<2.00	38.000
9-20-93	SED-03	93-AMSD93-1	<2.00	<40.0	<1.00	<2.00	1.4200	<0.100	<2.50	<2.00	<12.0	<1.00	<5.00	<8.00	<2.00	12.000
9-20-93	SED-04	93-AMSD94-1	<2.00	71.400	<1.00	9.400	22.4000	<0.100	<2.50	<2.00	<12.0	<1.00	43.000	<8.00	<2.00	133.000
9-20-93	SED-05	93-AMSD95-1	<2.00	<40.0	<1.00	3.400	7.8500	<0.100	<1.00	<2.00	<12.0	<1.00	13.800	<8.00	<2.00	53.400
9-20-93	SED-06	93-AMSD96-1	<2.00	62.700	<1.00	9.300	7.5000	<0.100	<2.50	<2.00	<12.0	<1.00	11.700	<8.00	<2.00	30.900
9-20-93	SED-07	93-AMSD97-1	<2.00	69.300	<1.00	8.500	8.3500	<0.100	<2.50	<2.00	<12.0	<1.00	9.600	<8.00	<2.00	29.900
9-20-93	DUP-SED-07	93-AMSDDUP97-1	<2.00	81.600	<1.00	11.200	10.1000	<0.100	<2.50	<2.00	<12.0	<1.00	11.500	<8.00	<2.00	36.100
9-20-93	SED-08	93-AMSD98-1	<2.00	61.400	<1.00	9.000	8.4000	<0.100	<2.50	<2.00	<12.0	<1.00	9.700	<8.00	<2.00	31.600
U.S. Geological Survey Published Average			7.00	670	NE	56	20	0.065	0.34	NE	0.62	0.97	27	19	9.8	65
N/A	N/A	N/A														

Notes:

Units for RFI samples are milligrams per kilogram (mg/kg) - equivalent to parts per million  
Units for U.S. Geological Survey Published Average are micrograms per gram (ug/g) - equivalent to parts per million

< not detected at quantification limit shown

N/A not analyzed

NE none established

Table 7. Surface Water Data Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Arsenic		Barium		Cadmium		Chromium		Lead		Mercury		Selenium	
			Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
9-20-93	WATER-02	93-AMSW92-1	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.010	<0.010	<0.0030	<0.0030	<0.00020	<0.00020	<0.0050	<0.0050
9-20-93	WATER-03	93-AMSW93-1	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.010	<0.010	<0.0030	<0.0030	<0.00020	<0.00020	<0.0050	<0.0050
9-20-93	WATER-04	93-AMSW94-1	0.013	<0.010	0.443	<0.200	<0.0050	<0.0050	<0.010	<0.010	0.0143	<0.0030	<0.00020	<0.00020	<0.0050	<0.0050
9-20-93	WATER-05	93-AMSW95-1	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.010	<0.010	<0.0030	<0.0030	<0.00020	<0.00020	<0.0050	<0.0050
9-20-93	DUP-WATER-05	93-AMSWDUP95-1	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.010	<0.010	<0.0030	<0.0030	<0.00020	<0.00020	<0.0050	<0.0050

Sample Date	Sample ID	Sample Description	Silver		Antimony		Beryllium		Copper		Nickel		Thallium		Zinc	
			Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
9-20-93	WATER-02	93-AMSW92-1	<0.010	<0.010	<0.060	<0.060	<0.0050	<0.0050	<0.025	<0.025	<0.040	<0.040	<0.010	<0.010	<0.020	<0.020
9-20-93	WATER-03	93-AMSW93-1	<0.010	<0.010	<0.060	<0.060	<0.0050	<0.0050	<0.025	<0.025	<0.040	<0.040	<0.010	<0.010	0.020	0.020
9-20-93	WATER-04	93-AMSW94-1	<0.010	<0.010	<0.060	<0.060	<0.0050	<0.0050	<0.025	<0.025	<0.040	<0.040	<0.010	<0.010	0.304	<0.020
9-20-93	WATER-05	93-AMSW95-1	<0.010	<0.010	<0.060	<0.060	<0.0050	<0.0050	<0.025	<0.025	<0.040	<0.040	<0.010	<0.010	<0.020	<0.020
9-20-93	DUP-WATER-05	93-AMSWDUP95-1	<0.010	<0.010	<0.060	<0.060	<0.0050	<0.0050	<0.025	<0.025	<0.040	<0.040	<0.010	<0.010	<0.020	<0.020

Sample Date	Sample ID	Sample Description	pH (S.U.)	Temperature		Specific Conductivity (umhos/cm)
				(C)	(F)	
9-20-93	WATER-02	93-AMSW92-1	7.76	16.1	61	392
9-20-93	WATER-03	93-AMSW93-1	8.09	28.2	83	590
9-20-93	WATER-04	93-AMSW94-1	6.85	17.2	63	460
9-20-93	WATER-05	93-AMSW95-1	7.09	16.0	61	430

Notes:

All units are milligrams per liter (mg/L).  
< not detected at quantification limit shown  
S.U. = Standard Units (pH)  
C = Centigrade  
F = Fahrenheit  
umhos/cm = micromohs per centimeter

123DATA/0316951M.WK1     SJP/mef/RJK

Table 8. Summary of Groundwater Monitoring Well Information  
Sauer-Sundstrand Facility  
Ames, Iowa

Well Designation	Well Depth	Screen Length (feet)	Screened Interval (feet bgs)	Drilling Method
MW-1				
MW-R2D	30	10	20-30	HSA, SC
MW-R2S	39		34-39	HSA, SC
MW-3	18	5	8-18	HSA, SC
MW-4	13	10	5-13	HSA, SC
MW-5	15	8	4-15	HSA, SC
MW-R6D	13	11	3-13	HSA, SC
	NOT INSTALLED	10	N/A	HSA, SC
		N/A		HSA to 60 feet bgs, MR to set STC, HSA from 60 to 90 feet bgs, DC
MW-R6S				
MW-10	17	10	7-17	HSA, SC
MW-11	16	3	13-16	HSA, SC
MW-12	18	3	15-18	HSA, SC
MW-R13	20	3	17-20	HSA, SC
MW-R14	22	10	12-22	HSA, SC
MW-15	18	10	8-18	HSA, SC
MW-R17	20	3	17-20	HSA, SC
	88	5	83-88	HSA, SC
MW-18				HSA to 60 feet bgs, MR to set STC, HSA from 60 to 90 feet bgs.
MW-19	15	3	12-15	HSA, SC
MW-20	15	3	12-15	HSA, SC
MW-21	15	3	12-15	HSA, SC
MW-22	14	3	11-14	HSA, SC
MW-23	15	3	12-15	HSA, SC
MW-24	15	3	12-15	HSA, SC
MW-25	10	3	7-10	HSA, SC
MW-26	12	3	9-12	HSA, SC
MW-27	13	3	10-13	HSA, SC
MW-28	67	3	64-67	HSA, SC
MW-29	16	3	13-16	HSA, SC
MW-R30	11	3	8-11	HSA, SC
MW-31	54	5	49-54	HSA, SC
MW-32	15	10	5-15	HSA, SC
	54	10	44-54	HSA, SC

NOTES:

1. HSA = Hollow Stem Augers
2. SC = Single Cased
3. MR = Mud Rotary
4. STC = Steel Casing
5. DC = Double Cased
6. NA = Not Applicable
7. bgs = below ground surface
8. Data reported to the nearest foot.

**Table 9. Groundwater Elevation Data**  
Sauer-Sundstrand Facility  
Ames, Iowa

Well Designation	TOIC Elevation (MSL)	Casing Stick-Up (ft)	Depth to Groundwater from TOIC (ft)	Depth to Groundwater from Ground Surface (ft)	Groundwater Elevation (MSL)
MW-1	973.71	2.51	4.61	2.10	969.10
MW-R2S	970.49	3.19	7.06	3.87	963.43
MW-R2D	970.41	3.11	8.31	5.2	962.10
MW-3	969.05	2.15	4.84	2.69	964.21
MW-4	970.39	2.29	4.51	2.22	965.88
MW-5	965.82	2.42	8.07	5.65	957.75
MW-R6S	965.39	2.39	8.47	6.08	956.92
MW-10	964.22	2.52	9.57	7.05	954.65
MW-11	963.26	2.66	11.23	8.57	952.03
MW-12	959.7	2.9	11.7	8.80	948.00
MW-R13	965.67	1.97	9.19	7.22	956.48
MW-R14	965.83	1.73	11.64	9.91	954.19
MW-15	957.99	2.79	6.18	3.39	951.81
MW-16	965.90	2.9	11.18	8.28	954.72
MW-R17	965.77	2.17	69.42	67.25	896.35
MW-18	956.73	2.93	5.86	2.93	950.87
MW-19	954.31	2.71	6.48	3.77	947.83
MW-20	956.66	2.26	6.92	4.66	949.74
MW-21	950.35	2.15	4.39	2.24	945.96
MW-22	950.13	2.53	5.38	2.85	944.75
MW-23	948.8	2.5	7.47	4.97	941.33
MW-24	947.06	2.56	6.0	3.44	941.06
MW-25	949.46	2.46	5.27	2.81	944.19
MW-26	954.3	2.5	6.84	4.34	947.46
MW-27	949.81	2.61	45.76	43.15	904.05
MW-28	957.17	2.47	4.47	2.00	954.70
MW-29	955.57	3.17	4.68	1.51	950.89
MW-R30	958.21	1.81	20.73	18.92	937.48
MW-31	953.60	2.10	6.45	4.35	947.15
MW-32	954.16	2.46	10.53	8.07	943.63

TOIC = Top of Inner Casing

MSL = Mean Sea Level

Groundwater data collected on September 8, 1994.

CAA/RJB



Table 10. Groundwater VOC Data Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Acetone	1,1-DCE	Methylene-chloride	1,1,2-DCE	1,1-DCA	c-1,2-DCE	1,1,1-TCA	1,2-DCA	TCE	1,1,2-TCA	PCE	Total Xylenes
9-9-94	94-AMGW1-1	MW-1	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-9-94	94-AMGWR2D-1	MW-R2D	25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-9-94	94-AMGWR2S-1	MW-R2S	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGW3-1	MW-3	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8.7
9-13-94	94-AMGW4-1	MW-4	< 25 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGW4D-1	MW-4 (dup)	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGW5-1	MW-5	< 25	34	< 5.0	< 5.0	37	27	64	< 5.0	26	< 5.0	50	< 5.0
9-13-94	94-AMGWR6S-1	MW-R6S	< 25	33	< 5.0	< 5.0	38	700	65	< 5.0	31	< 5.0	730	< 5.0
9-15-94	94-AMGW10-1	MW-10	< 25	54	< 5.0	< 5.0	9.6 (EST)	110	410	< 5.0	28	< 5.0	1800	< 5.0
9-15-94	94-AMGW10D-1	MW-10 (dup)	< 25	84	< 5.0	< 5.0	13 (EST)	120	530	< 5.0	31	< 5.0	1900	< 5.0
9-15-94	94-AMGW11-1	MW-11	< 25	130	< 5.0	7.1 (EST)	44	730	810	< 5.0	91	8.0	2500	< 5.0
9-13-94	94-AMGW12-1	MW-12	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-14-94	94-AMGWR13-1	MW-R13	< 25	250	9.1 (EST) B	< 5.0	560	200	970	5.8	72	30	1100	< 5.0
9-14-94	94-AMGWR14-1	MW-R14	< 25	24 (EST)	< 5.0	< 5.0	13 (EST)	< 5.0	270	< 5.0	< 5.0	< 5.0	34	< 5.0
9-14-94	94-AMGW15-1	MW-15	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-16-94	94-AMGWR17-1	MW-R17	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGW18-1	MW-18	< 25 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0	< 5.0	< 5.0	7.7
9-15-94	94-AMGW19-1	MW-19	< 25	140	< 5.0	< 5.0	130	150	900	< 5.0	170	18	1600 (EST)	< 5.0
9-15-94	94-AMGW20-1	MW-20	< 25	110	< 5.0	< 5.0	70	90	760	< 5.0	26	20	1800	< 5.0
9-12-94	94-AMGW21-1	MW-21	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-9-94	94-AMGW22-1	MW-22	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-9-94	94-AMGW23-1	MW-23	66	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGW24-1	MW-24	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGW25-1	MW-25	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	16
9-12-94	94-AMGW25D-1	MW-25 (dup)	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGW26-1	MW-26	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGW27-1	MW-27	< 25 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGW28-1	MW-28	< 25 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0	< 5.0	6.2	< 5.0
9-14-94	94-AMGW29-1	MW-29	< 25	33	< 5.0	< 5.0	17	40	180	< 5.0	64	< 5.0	810	< 5.0
9-16-94	94-AMGWR30-1	MW-R30	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	25	< 5.0
9-14-94	94-AMGW31-1	MW-31	< 25	< 5.0	< 5.0	< 5.0	< 5.0	8.3	25	< 5.0	19	< 5.0	36	< 5.0
9-14-94	94-AMGW31D-1	MW-31 (dup)	< 25	< 5.0	< 5.0	< 5.0	< 5.0	7.7	23	< 5.0	17	< 5.0	34	< 5.0
9-13-94	94-AMGW32-1	MW-32	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
N/A	N/A	MCL	NE	7	5	100	NE	70	200	5	5	5	5	10000

Notes:

All units are micrograms per liter (ug/L).

< Not detected above quantitation limit shown.

N/A = Not Applicable

B = Compound detection attributed to laboratory of field sampling contamination, compound detected in the environmental sample at a concentration less than 10 times (for acetone, methylene chloride, 2-butanone and toluene) or 5 times (all other target compounds) the amount detected in the associated internal or external blanks.

UJ = Estimated quantification limit.

Table 11. Groundwater Metals Data Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Arsenic		Barium		Beryllium		Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Zinc	
			Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
9-9-94	94-AMGW1-1	MW-1	0.020	<0.010	0.250	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	0.0040	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.053	<0.020
9-9-94	94-AMGWR2D-1	MW-R2D	0.013	<0.010	0.621	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0510	<0.010	0.081	<0.025	0.0291	<0.0030	<0.00020	<0.00020	0.060	<0.040	0.198	<0.020
9-9-94	94-AMGWR2S-1	MW-R2S	0.041	<0.010	0.908	<0.200	<0.0050	<0.0050	0.0028	<0.0020	0.0735	<0.010	0.106	<0.025	0.0530	<0.0030	<0.00020	<0.00020	0.068	<0.040	0.276	<0.020
9-12-94	94-AMGW3-1	MW-3	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	<0.0030	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.040	<0.020
9-13-94	94-AMGW4-1	MW-4	<0.010	<0.010	0.220	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	0.037	<0.025	0.0065	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.085	<0.020
9-13-94	94-AMGW4D-1	MW-4-DUP	<0.010	<0.010	0.221	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0108	<0.010	0.028	<0.025	0.0072	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.090	<0.020
9-13-94	94-AMGW5-1	MW-5	<0.010	<0.010	0.292	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0148	<0.010	<0.025	<0.025	0.0107	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.092	<0.020
9-13-94	94-AMGWR6S-1	MW-R6S	<0.010	<0.010	0.519	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0334	<0.010	<0.025	<0.025	0.0150	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.112	0.023
9-15-94	94-AMGW10-1	MW-10	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.2580	<0.010	<0.025	<0.025	0.0080	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.033	<0.020
9-15-94	94-AMGW10D-1	MW-10-DUP	<0.010	<0.010	0.202	<0.200	<0.0050	<0.0050	0.0025	<0.0020	0.1750	<0.010	<0.025	<0.025	0.0102	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.043	<0.020
9-15-94	94-AMGW11-1	MW-11	0.032	<0.010	0.765	0.367	<0.0050	<0.0050	0.0022	<0.0020	0.6050	<0.010	0.029	<0.025	0.0254	<0.0030	<0.00020	<0.00020	0.067	<0.040	0.119	<0.020
9-13-94	94-AMGW12-1	MW-12	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0123	<0.010	<0.025	<0.025	0.0035	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.028	<0.020
9-14-94	94-AMGWR13-1	MW-R13	0.019	<0.010	1.720	<0.200	0.0088	<0.0050	0.0037	<0.0020	0.1540	<0.010	0.276	<0.025	0.0810	<0.0030	0.0006	<0.00020	0.256	<0.040	0.661	<0.020
9-14-94	94-AMGWR14-1	MW-R14	0.015	<0.010	2.420	<0.200	0.0110	<0.0050	0.0036	<0.0020	0.2000	<0.010	0.371	<0.025	0.1480	<0.0030	0.0007	<0.00020	0.358	<0.040	1.070	<0.020
9-14-94	94-AMGW15-1	MW-15	0.011	<0.010	0.256	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0132	<0.010	<0.025	<0.025	0.0076	0.0035	<0.00020	<0.00020	<0.040	<0.040	0.034	0.021
9-16-94	94-AMGWR17-1	MW-R17	<0.010	<0.010	0.833	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0745	<0.010	0.132	<0.025	0.0342	<0.0030	<0.00020	<0.00020	0.149	<0.040	0.278	<0.020
9-13-94	94-AMGW18-1	MW-18	<0.010	<0.010	0.236	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	0.0083	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.028	<0.020
9-15-94	94-AMGW19-1	MW-19	<0.010	<0.010	0.453	0.292	<0.0050	<0.0050	0.0039	0.0020	0.3420	<0.010	<0.025	<0.025	0.0176	0.0067	<0.00020	<0.00020	0.447	0.235	0.045	<0.020
9-15-94	94-AMGW20-1	MW-20	0.019	<0.010	0.857	0.253	<0.0050	<0.0050	<0.0020	<0.0020	0.0570	<0.010	0.098	<0.025	0.0395	0.0050	<0.00020	<0.00020	0.100	<0.040	0.226	<0.020
9-12-94	94-AMGW21-1	MW-21	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	0.0095	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.058	<0.020
9-9-94	94-AMGW22-1	MW-22	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0145	<0.010	<0.025	<0.025	0.0076	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.063	<0.020
9-9-94	94-AMGW23-1	MW-23	0.016	<0.010	0.485	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0424	<0.010	0.043	<0.025	0.0186	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.147	<0.020
9-12-94	94-AMGW24-1	MW-24	<0.010	<0.010	0.231	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0380	<0.010	0.040	<0.025	0.0126	<0.0030	<0.00020	<0.00020	0.068	<0.040	0.156	<0.020
9-12-94	94-AMGW25-1	MW-25	<0.010	<0.010	0.232	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0211	<0.010	<0.025	<0.025	0.0089	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.020	<0.020
9-12-94	94-AMGW25D-1	MW-25-DUP	<0.010	<0.010	0.274	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0308	<0.010	0.025	<0.025	0.0115	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.114	<0.020
9-12-94	94-AMGW26-1	MW-26	0.015	<0.010	0.314	<0.200	<0.0050	<0.0050	0.0045	<0.0020	0.0380	<0.010	0.060	<0.025	0.0162	<0.0030	<0.00020	<0.00020	0.043	<0.040	0.132	<0.020
9-12-94	94-AMGW27-1	MW-27	0.072	<0.010	4.400	0.665	0.0126	<0.0050	0.0214	<0.0020	0.2690	<0.010	0.545	<0.025	0.2820	<0.0030	0.0006	<0.00020	1.060	<0.040	1.430	<0.020
9-13-94	94-AMGW28-1	MW-28	0.015	<0.010	0.487	<0.200	<0.0050	<0.0050	0.0042	<0.0020	0.0484	<0.010	<0.025	<0.025	0.0193	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.130	<0.020
9-14-94	94-AMGW29-1	MW-29	0.011	<0.010	0.0653	<0.200	<0.0050	<0.0050	0.0032	<0.0020	0.0840	<0.010	0.105	<0.025	0.0245	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.199	<0.020
9-16-94	94-AMGWR30-1	MW-R30	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	<0.0030	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.040	<0.020
9-14-94	94-AMGW31-1	MW-31	<0.010	<0.010	0.345	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	0.0575	<0.010	0.027	<0.025	0.0153	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.104	<0.020
9-14-94	94-AMGW31D-1	MW-31-DUP	0.016	<0.010	0.492	<0.200	<0.0050	<0.0050	0.0026	<0.0020	0.0680	<0.010	0.034	<0.025	0.0220	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.160	<0.020
9-13-94	94-AMGW32-1	MW-32	0.068	0.022	2.730	0.285	0.0100	<0.0050	0.0034	<0.0020	0.2360	<0.0100	0.343	<0.025	0.1200	<0.0030	0.0007	0.0004	0.535	<0.040	0.964	<0.020
9-9-94	94-AMGWEB1-1	EQUIPMENT BLANK	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	<0.025	<0.0030	<0.0030	<0.00020	<0.00020	<0.040	<0.040	0.030	<0.020
9-14-94	94-AMGWR14EB-1	EQUIPMENT BLANK	<0.010	<0.010	<0.200	<0.200	<0.0050	<0.0050	<0.0020	<0.0020	<0.010	<0.010	<0.025	0.138	0.0045	0.0074	<0.00020	<0.00020	<0.040	<0.040	<0.020	0.088
NA	NA	MCL	0.05		2.0		0.001		0.005		0.1		1.3		0.015		0.002		0.100		5.0*	

NOTES:

All units are milligrams per liter (mg/L)  
Antimony, Selenium, Silver and Thallium were not detected in any sample above the Method Detection Limit (MDL).  
Following samples did not detect any of the fourteen metals analyzed for: MW-13, Equipment Blank Samples (94-AMGWEB26-1, 94-AMGW18EB-1, 94-AMG11EB-1, and 94-AMGWR17EB-1), and Source Water Sample (94-AMSW12-1).  
All concentrations are in milligrams per liter (mg/L).  
MCL = Maximum Contaminant Level  
\* Secondary Maximum Containment Level



Table 12. Hydraulic Conductivity Test Summary  
Sauer-Sundstrand Facility  
Ames, Iowa

Well ID	Aquifer Screened	Test Type	Hydraulic Conductivity		
			(feet/min)	(cm/sec)	(feet/day)
MWR2D	Intermediate	Falling	1.7376E-06	8.8270E-07	2.502E-03
MWR6S	Shallow	Falling	1.3682E-03	6.9505E-04	1.970E+00
		Rising	2.7529E-04	1.3985E-04	3.964E-01
MW11	Shallow	Falling	2.3013E-02	1.1691E-02	3.314E+01
MW12	Shallow	Falling	2.2683E-05	1.1523E-05	3.266E-02
		Rising	1.7663E-05	8.9728E-06	2.543E-02
MWR13	Shallow	Falling	8.8150E-04	4.4780E-04	1.269E+00
		Rising	1.2560E-03	6.3805E-04	1.809E+00
MWR14	Shallow	Rising	1.8988E-03	9.6459E-04	2.734E+00
MW18	Shallow	Falling	5.7818E-05	2.9372E-05	8.326E-02
		Rising	6.5655E-06	3.3353E-06	9.454E-03
MW19	Shallow	Falling	4.7091E-05	2.3922E-05	6.781E-02
		Rising	4.5673E-06	2.3202E-06	6.577E-03
MW21	Shallow	Falling	2.1556E-03	1.0950E-03	3.104E+00
		Rising	1.2382E-03	6.2901E-04	1.783E+00
MW22	Shallow	Falling	2.0340E-03	1.0333E-03	2.929E+00
		Rising	1.3800E-03	7.0104E-04	1.987E+00
MW23	Shallow	Falling	9.0109E-05	4.5775E-05	1.298E-01
		Rising	1.2931E-04	6.5689E-05	1.862E-01
MW24	Shallow	Falling	1.6298E-04	8.2794E-05	2.347E-01
		Rising	1.3971E-04	7.0973E-05	2.012E-01
MW27	Intermediate	Falling	1.0615E-04	5.3924E-05	1.529E-01
		Rising	1.0117E-04	5.1394E-05	1.457E-01
MWR30	Intermediate	Falling	1.0420E-06	5.2934E-07	1.500E-03
MW31	Shallow	Falling	7.8440E-03	3.9848E-03	1.130E+01
		Rising	2.8740E-02	1.4600E-02	4.139E+01

Table 13. Phase II - VOC QA/QC Data  
Sauer-Sundstrand Facility  
Ames, Iowa

Sample Date	Sample ID	Sample Description	Acetone	1,1-DCE	Methylene chloride	t-1,2-DCE	1,1-DCE	2-Butanone (MEK)	c-1,2-DCE	1,1,1-TCA	1,2-DCA	TCE	Toluene	1,1,2-TCA	PCE	Total xylenes
9-8-94	94-AMSW12-1	SOURCE WATER	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0
9-12-94	94-AMSW13-1	SOURCE WATER	BQL	< 5.0	BQL	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-2-94	94-AMTB13-1	TRIP BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-9-94	94-AMTB14-1	TRIP BLANK	BQL	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMTB15-1	TRIP BLANK	BQL	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMTB16-1	TRIP BLANK	BQL	< 5.0	BQL	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMTB17-1	TRIP BLANK	< 25	< 5.0	BQL	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGWTB18-1	TRIP BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-14-94	94-AMTB19-1	TRIP BLANK	< 25	< 5.0	BQL	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-14-94	94-AMTB20-1	TRIP BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-15-94	94-AMTB21-1	TRIP BLANK	< 25	< 5.0	BQL	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-15-94	94-AMTB22-1	TRIP BLANK	< 25	< 5.0	BQL	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-16-94	94-AMTB23-1	TRIP BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-9-94	94-AMGWEB1-1	EQUIP. BLANK	BQL	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-15-94	94-AMGW11EB-1	EQUIP. BLANK	< 25	< 5.0	BQL	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0
9-14-94	94-AMGWR14EB-1	EQUIP. BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0
9-16-94	94-AMGWR17EB-1	EQUIP. BLANK	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-13-94	94-AMGW18EB-1	EQUIP. BLANK	< 25	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
9-12-94	94-AMGWEB26-1	EQUIP. BLANK	BQL	< 5.0	< 5.0	< 5.0	< 5.0	BQL	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

Notes:

All units are micrograms per liter (ug/L)

< = not detected above quantification limit shown

BQL = detected below quantification limit

J = estimated value

UJ = estimated quantification limit

N/A = not applicable

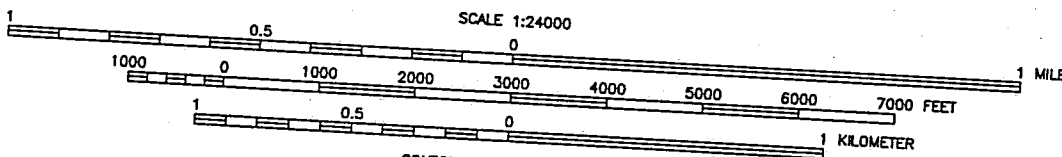
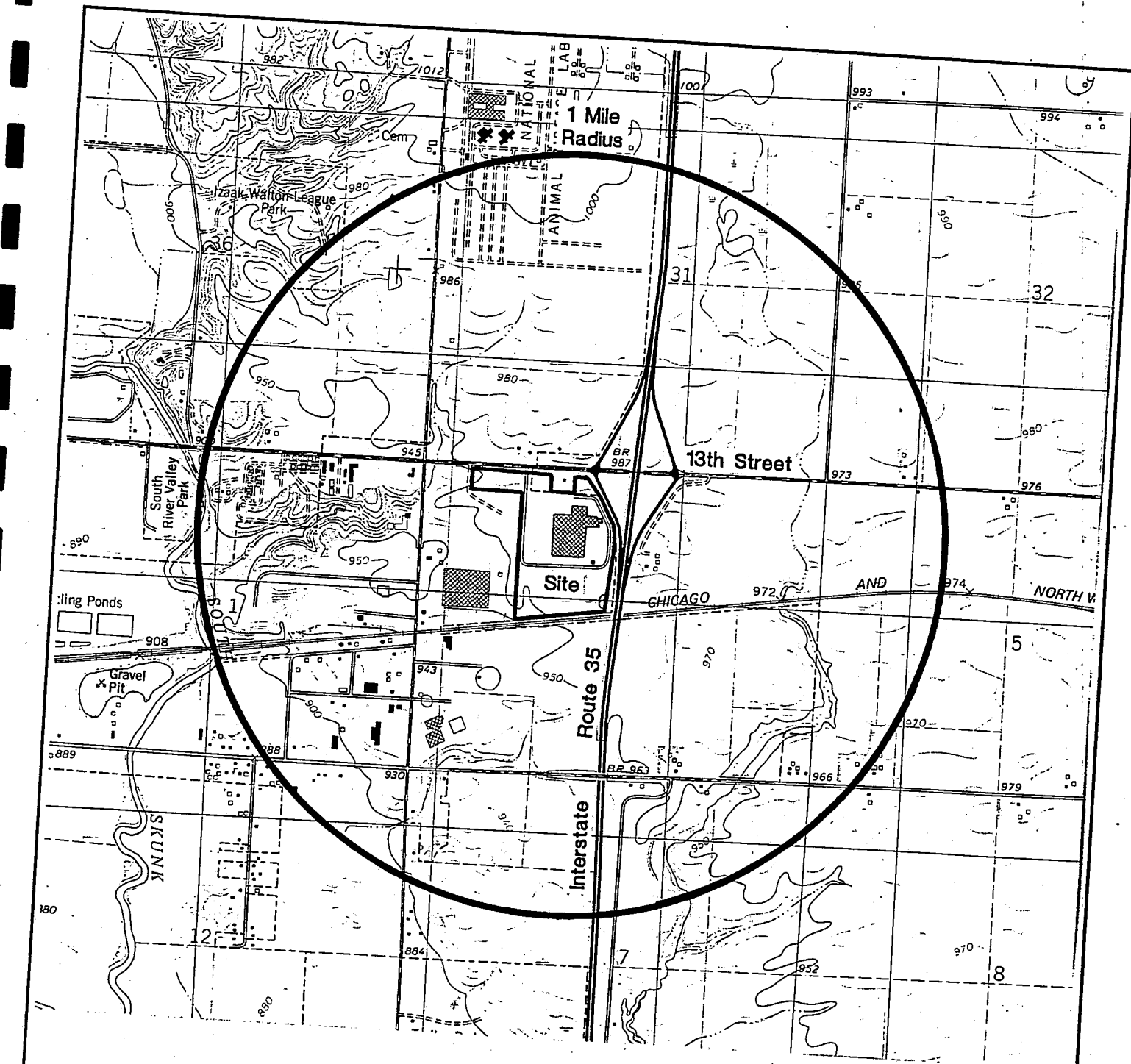
Samples analyzed for full range of Method 8260 analytes

Only those compounds above detection limit in one or more samples are reported

## **FIGURES**

SUNDSTRA/1104941M.WP-65  
June 9, 1995

**Harding Lawson Associates**



CONTOUR INTERVAL 10 FEET  
 NATIONAL GEODETIC VERTICAL DATUM OF 1929  
 REFERENCE: U.S.G.S. 7.5 MINUTE SERIES, PHOTO REVISED 1975  
 THE SITE IS LOCATED IN SECTION 6, TOWNSHIP 83 NORTH, RANGE 23 WEST



Ames East  
 Quadrangle  
 Location



**Harding Lawson Associates**  
 Engineering and  
 Environmental Services

DRAWN  
 EWS

PROJECT NUMBER  
 23088,1.16

**Site Vicinity Map**  
 Hydro-Transmission Plant  
 2800 East 13th Street  
 Ames, Iowa 50010

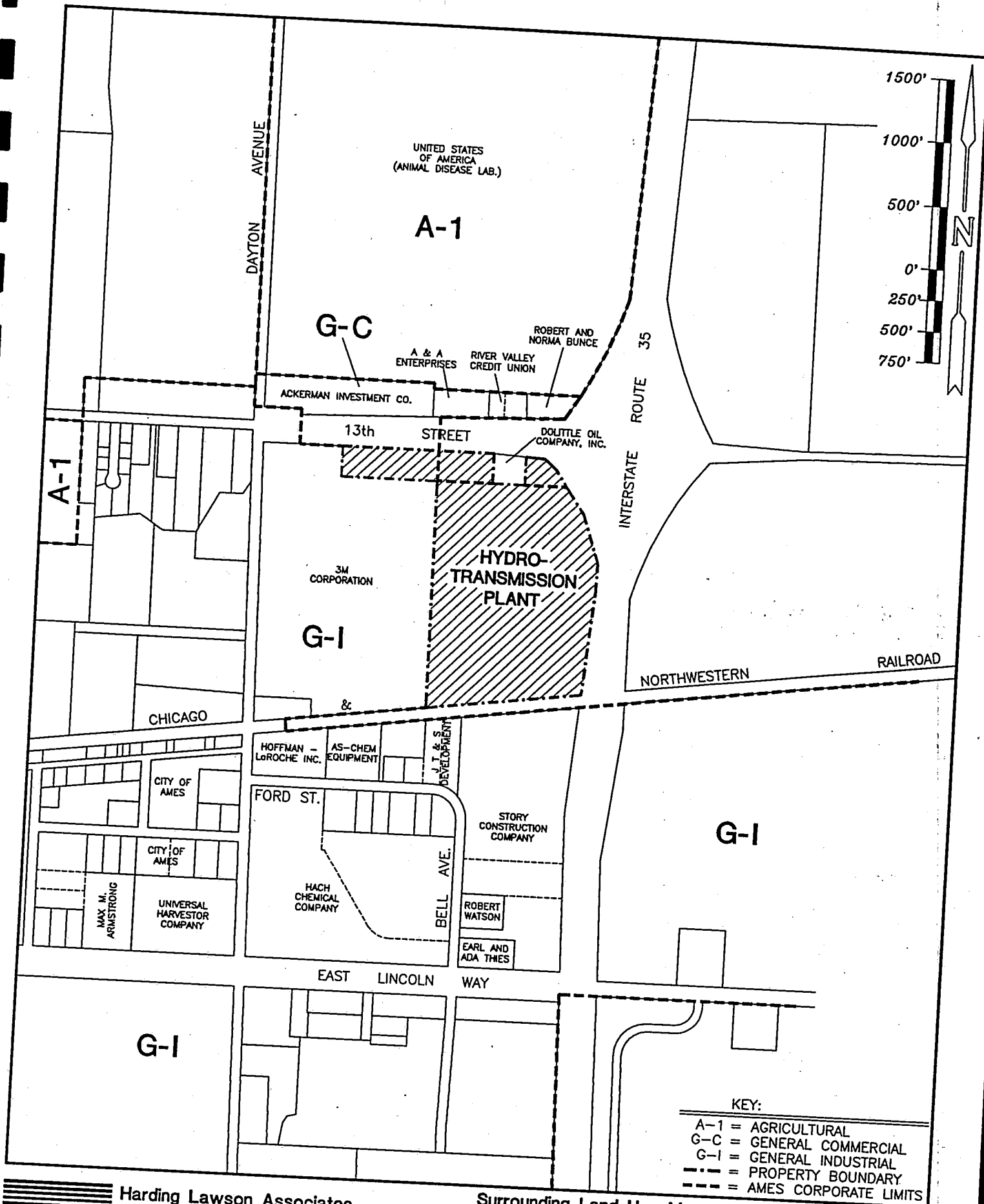
APPROVED  
*J. Bryan*

DATE  
 06/09/95

REVISED DATE

FIGURE

1



**Harding Lawson Associates**  
Engineering and  
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23088,1.16

**Surrounding Land Use Map**  
Hydro-Transmission Plant  
2800 East 13th Street  
Ames, Iowa 50010

APPROVED

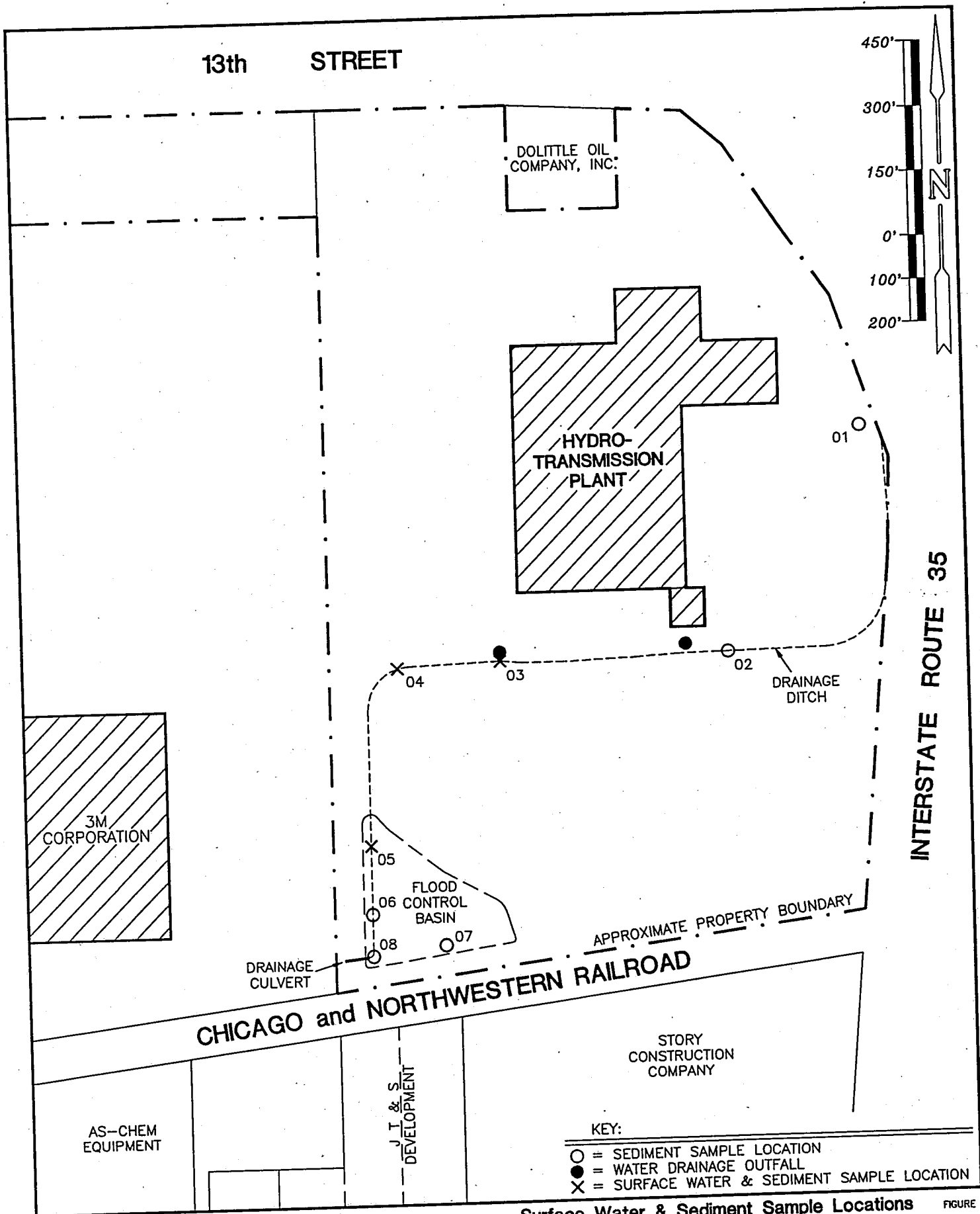
*T. Bryan*

DATE  
06/09/95

REVISED DATE

FIGURE

**2**



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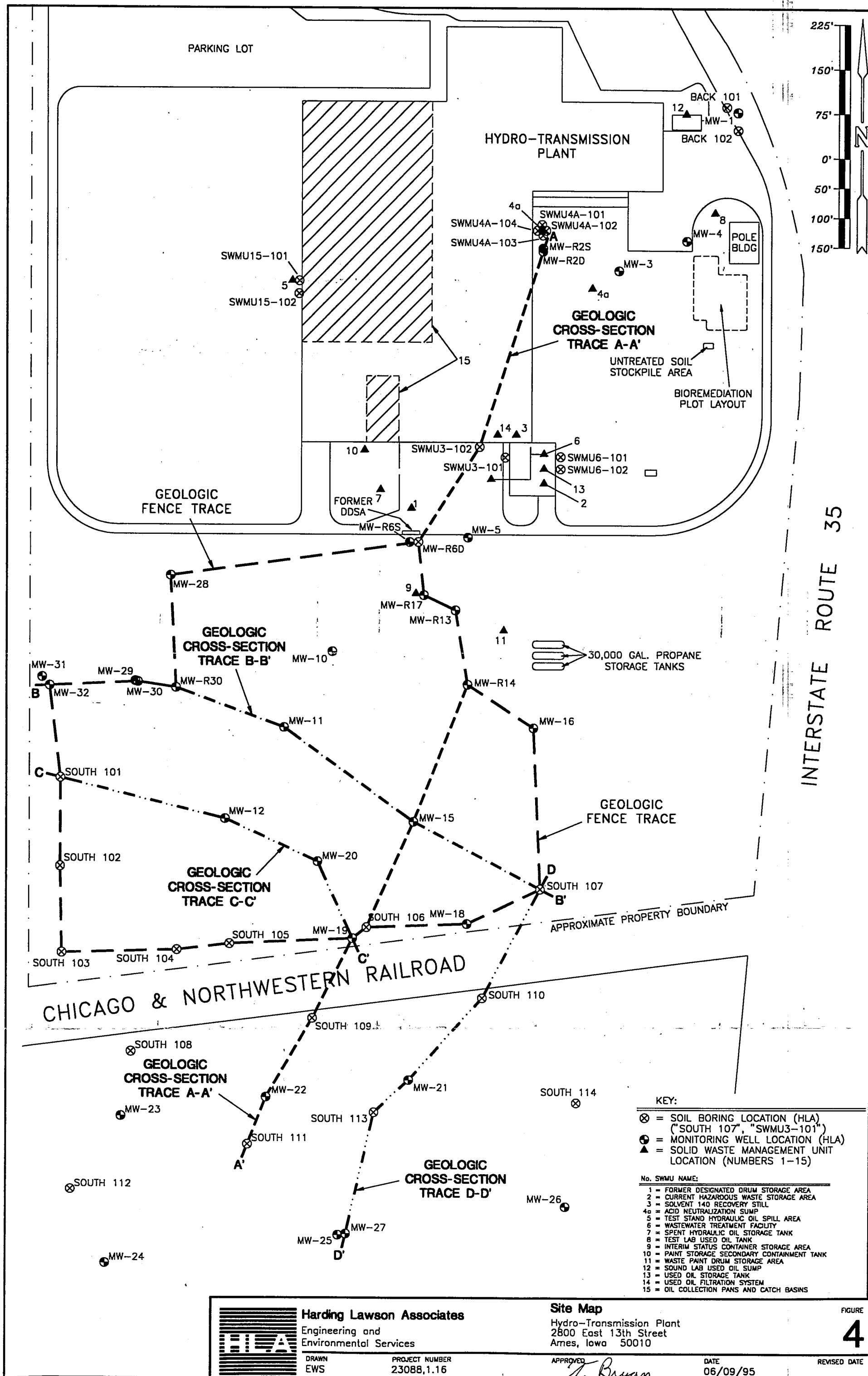
**Surface Water & Sediment Sample Locations**  
Hydro-Transmission Plant  
2800 East 13th Street  
Ames, Iowa 50010

*T. Bryan*

DATE  
06/09/95

REVISED DATE

FIGURE  
**3**



**Harding Lawson Associates**  
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Environmental Services

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PROJECT NUMBER  
23088.1.16

**Site Map**

Hydro-Transmission Plant  
2800 East 13th Street  
Ames, Iowa 50010

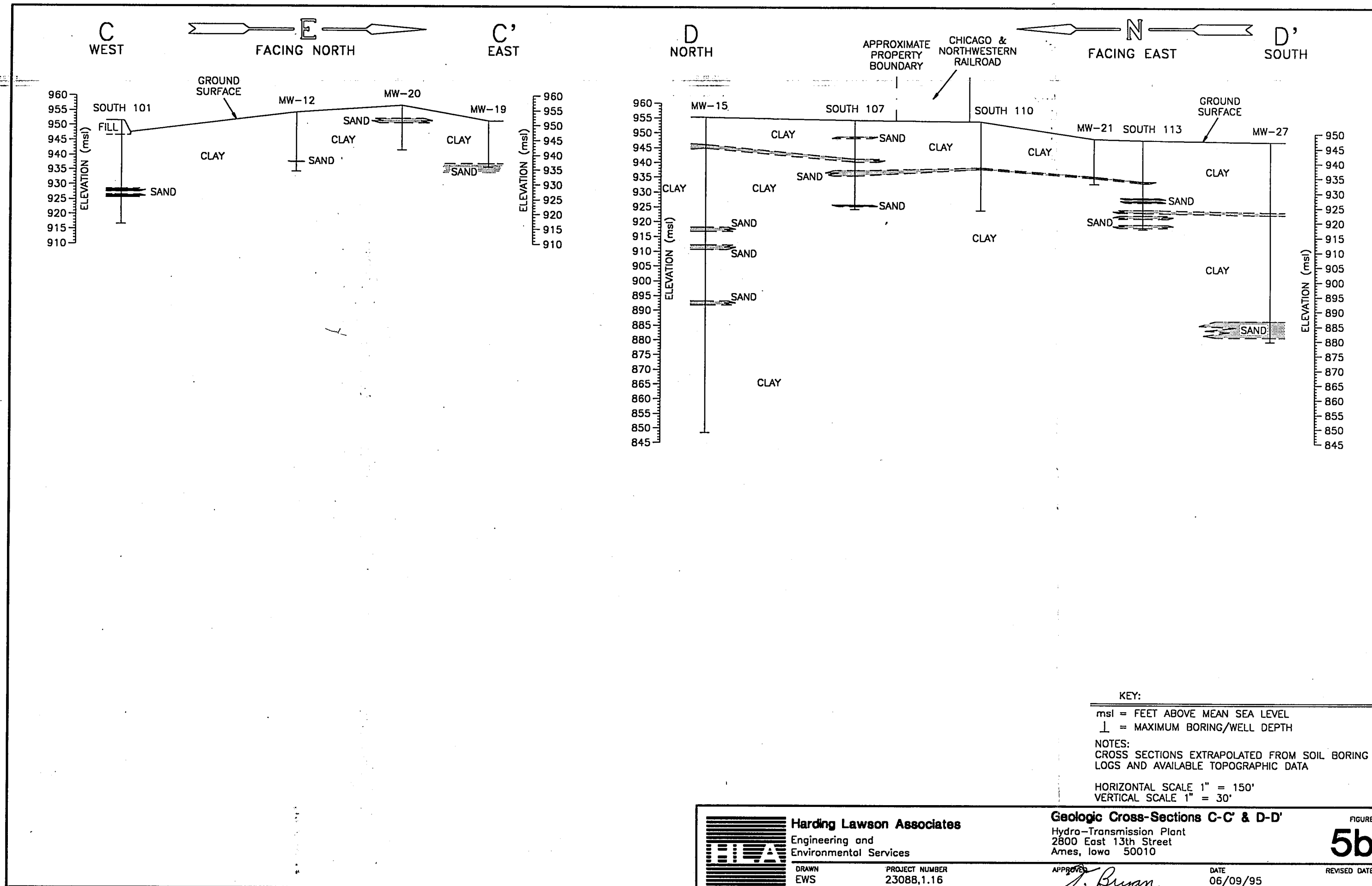
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*J. Bryan*

DATE  
06/09/95

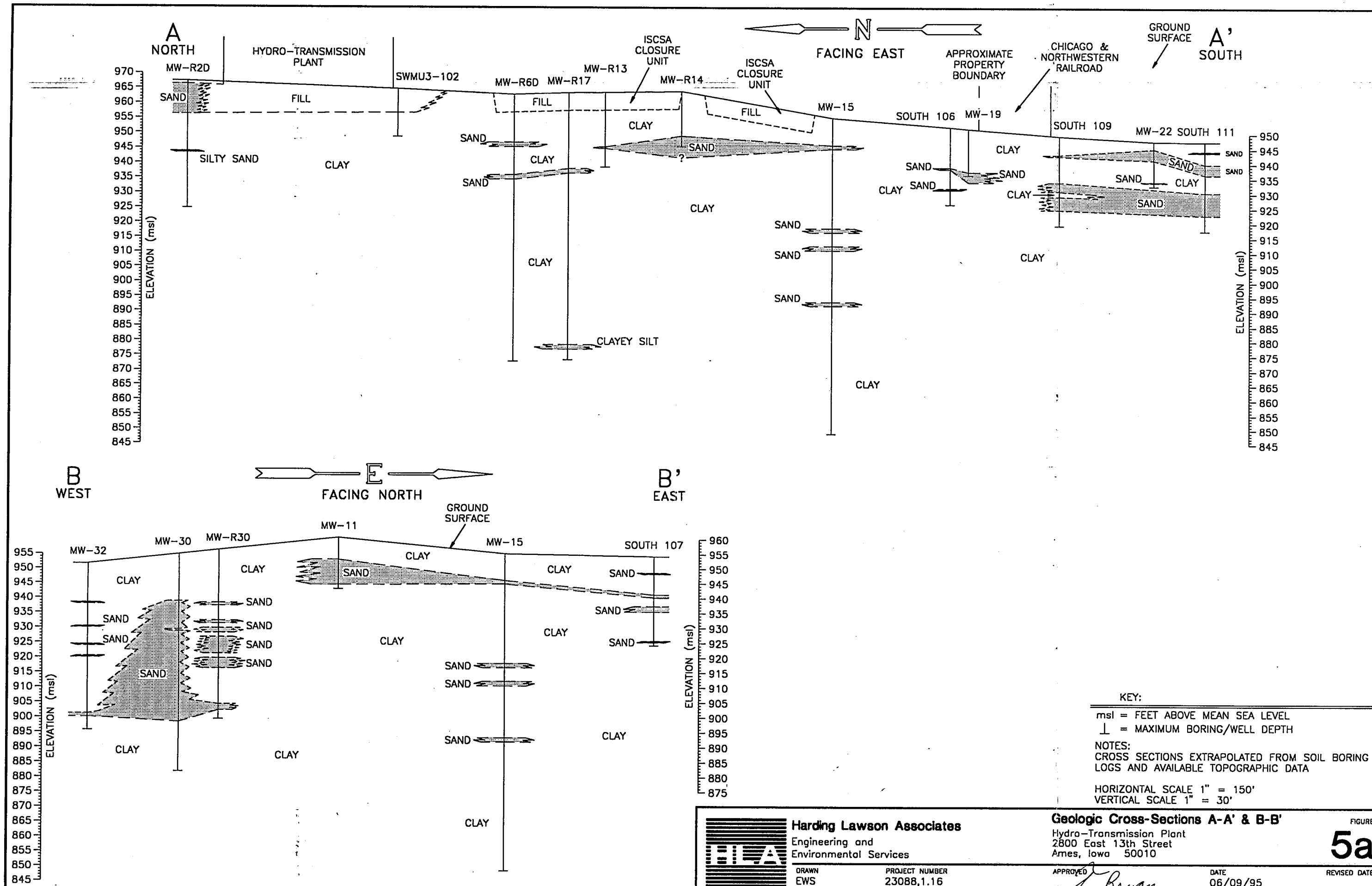
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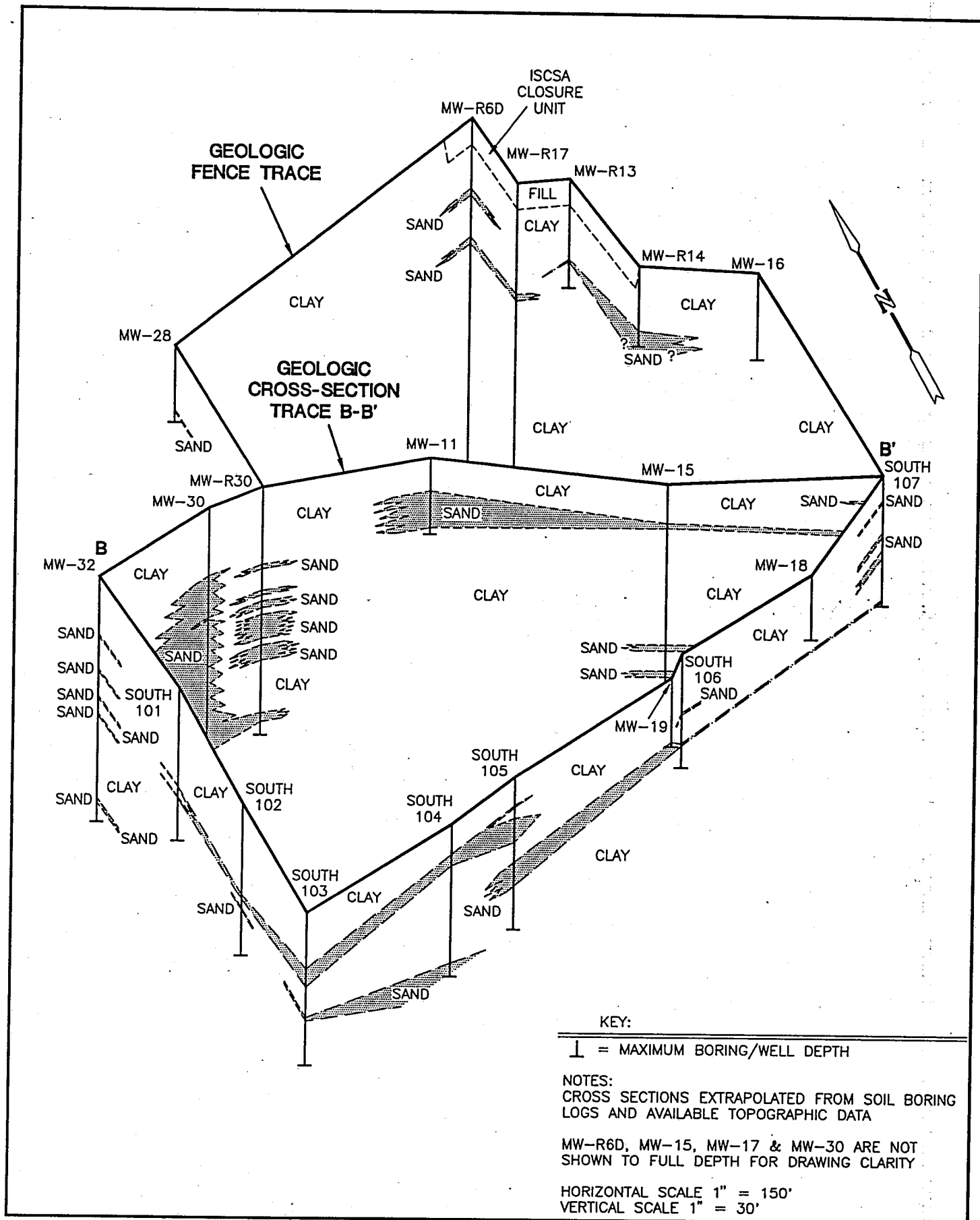
FIGURE

**4**









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 Engineering and  
 Environmental Services

**Geologic Fence Diagram & Cross-Section B-B'**  
 Hydro-Transmission Plant  
 2800 East 13th Street  
 Ames, Iowa 50010

**FIGURE 6**

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EWS

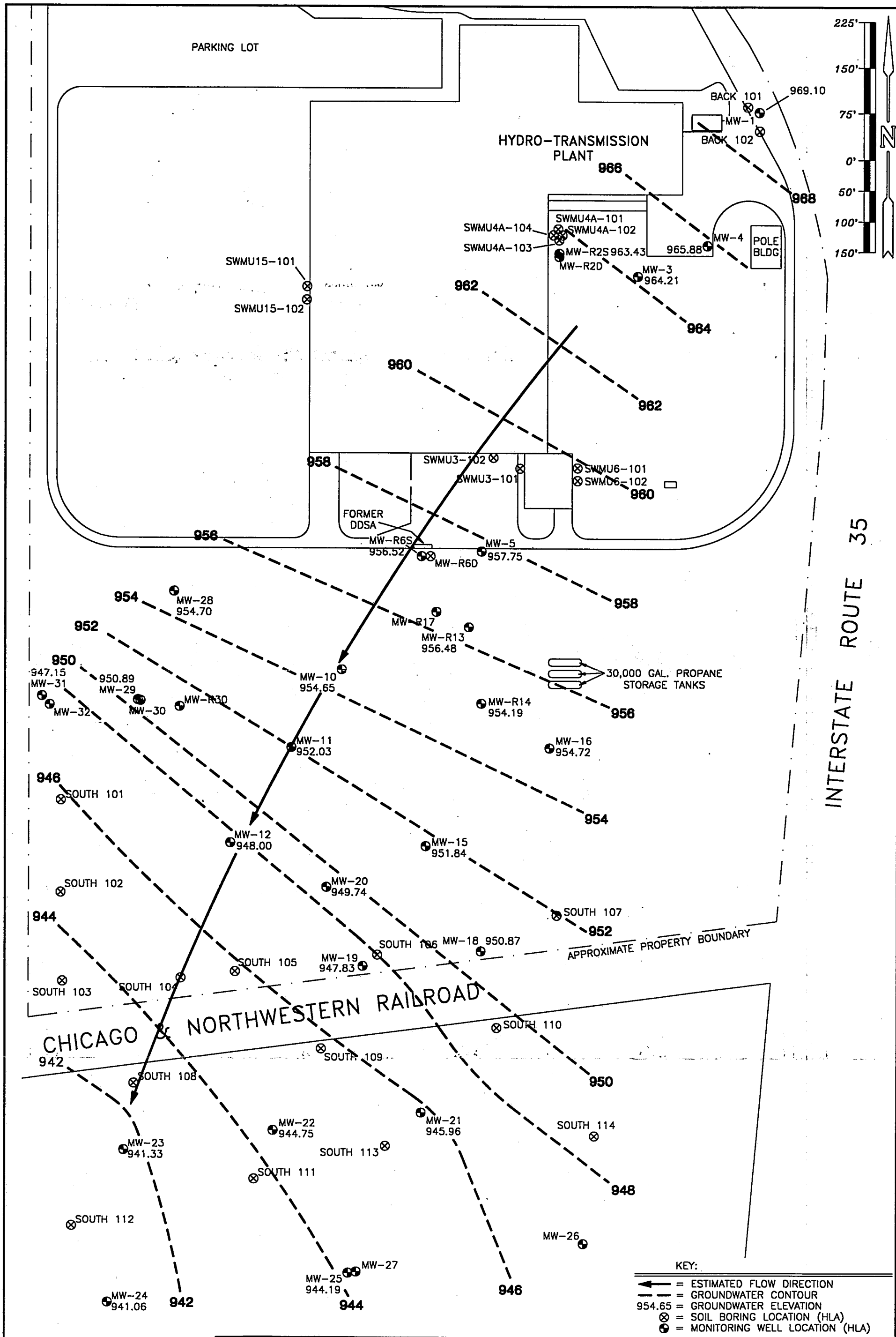
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**Shallow Groundwater Contour Map**

Hydro-Transmission Plant  
2800 East 13th Street  
Ames, Iowa 50010

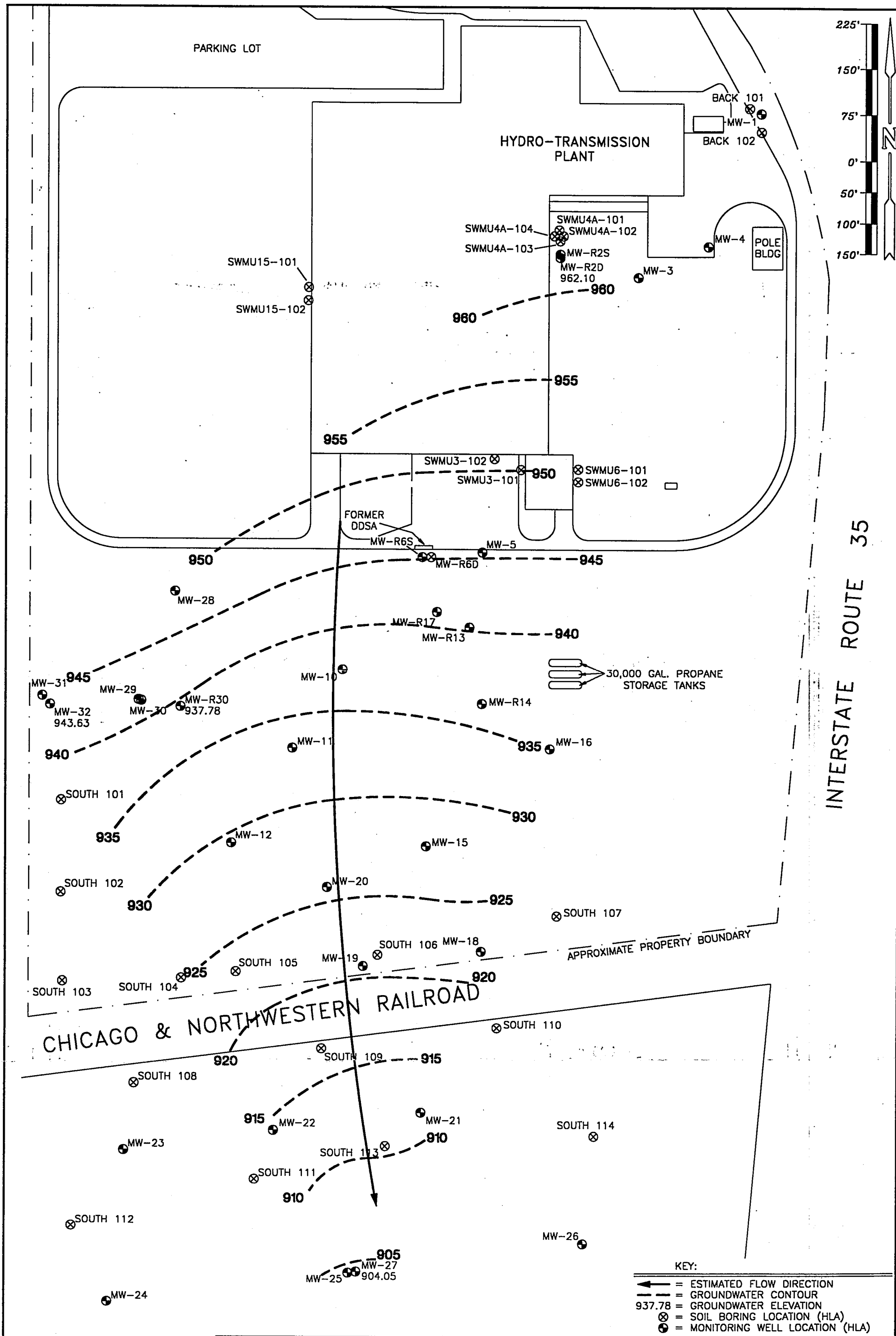
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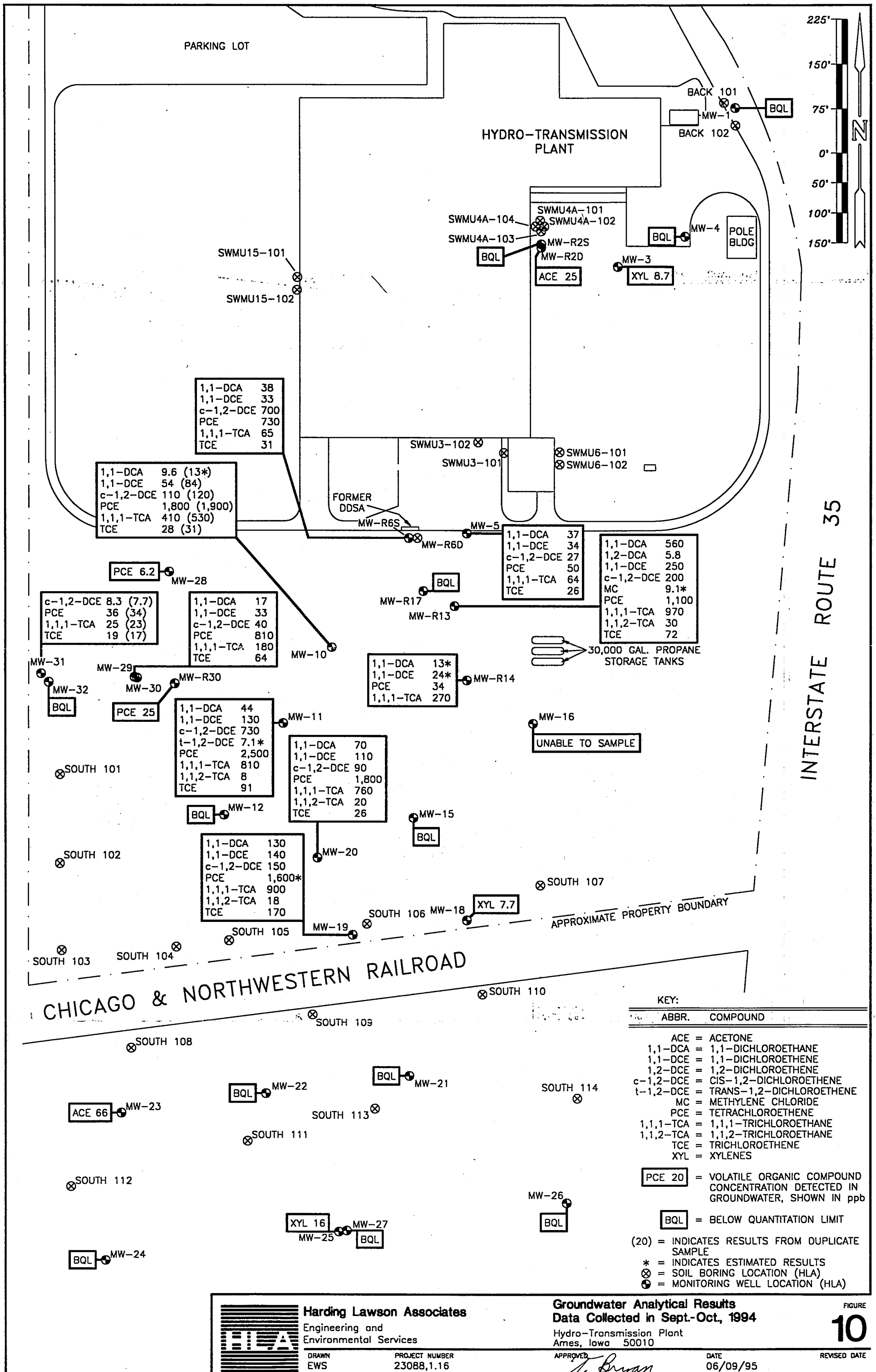
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FIGURE

**7**







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**Groundwater Analytical Results**  
**Data Collected in Sept.-Oct., 1994**

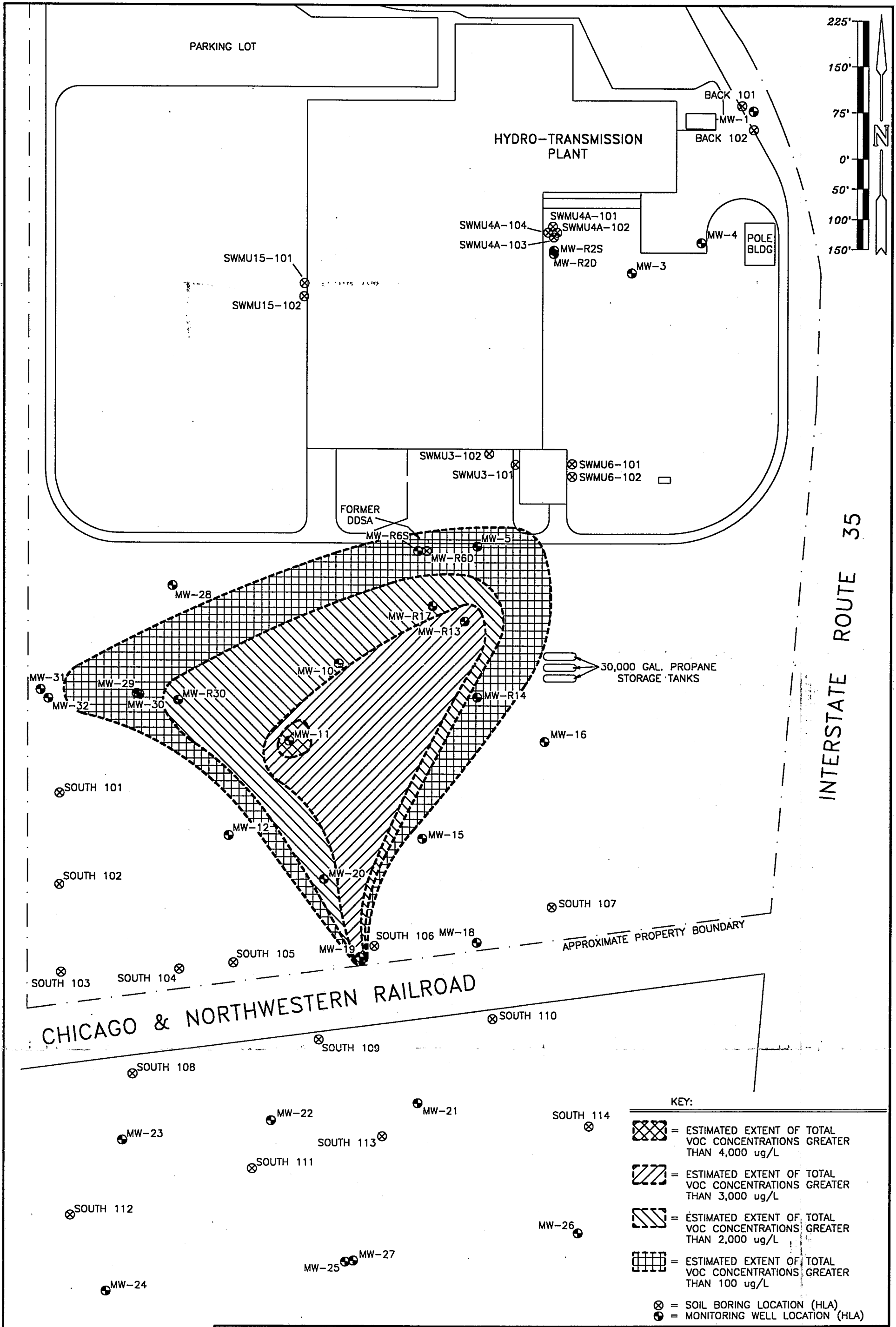
Hydro-Transmission Plant  
Ames, Iowa 50010

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*T. Bryan*

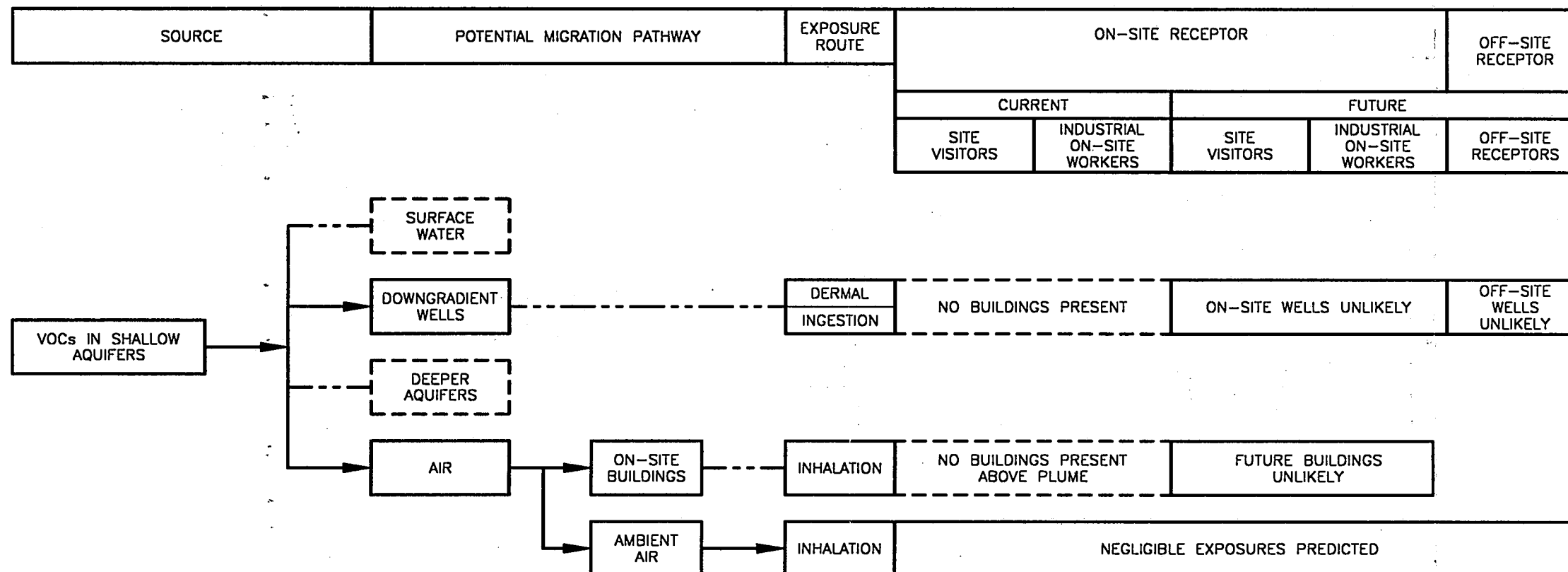
DATE  
06/09/95

FIGURE  
**10**

REVISED DATE



- KEY:
- = ESTIMATED EXTENT OF TOTAL VOC CONCENTRATIONS GREATER THAN 4,000 ug/L
  - = ESTIMATED EXTENT OF TOTAL VOC CONCENTRATIONS GREATER THAN 3,000 ug/L
  - = ESTIMATED EXTENT OF TOTAL VOC CONCENTRATIONS GREATER THAN 2,000 ug/L
  - = ESTIMATED EXTENT OF TOTAL VOC CONCENTRATIONS GREATER THAN 100 ug/L
  - = SOIL BORING LOCATION (HLA)
  - = MONITORING WELL LOCATION (HLA)



KEY:

— = POTENTIAL PATHWAY  
 - - - = INCOMPLETE PATHWAY



**Harding Lawson Associates**  
 Engineering and  
 Environmental Services

DRAWN EWS PROJECT NUMBER 23088.1.16

**Conceptual Site Model**  
 Hydro-Transmission Plant  
 2800 East 13th Street  
 Ames, Iowa 50010

APPROVED *J. Bryan*

DATE 06/09/95

REVISED DATE

FIGURE  
**12**



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Sauer-Sundstrand Facility  
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June 7, 1995

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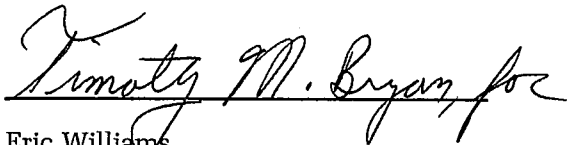
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Senior Project Manager